The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 12. **DECEMBER, 1910.** **No. 108.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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Forthcoming Events.

DECEMBER 3.

British Foundrymen's Association (Lancashire Branch).—"Imperfect Castings," by S. G. Smith (Chesterfield).

DECEMBER 5.

Royal Society of Arts.—Cantor Lecture: "Industrial Pyrometry," by C. E. Darling (Lecture III).

DECEMBER 10.

British Foundrymen's Association (Birmingham Branch).—"Foundry Difficulties" (discussion).

NOTES AND COMMENTS.

The Solution of a Copper Casting Problem.

The difficulty of obtaining sound castings of high electric conductivity has become a familiar feature of copper founding, and as the requirements of electric engineers tend to become rather more exacting than otherwise, the troubles of the foundryman in handling this class of work do not diminish. It is a practical impossibility to cast pure copper under ordinary conditions and get sound work, for the metal rapidly oxidises when molten, and tends also to absorb its own oxides, making it necessary to use some element to deoxidise the metal, or eliminate the oxygen by combining with it. For general purposes, such additions as silicon, magnesium and phosphorus are added, and the use of these allows the copper to be cast without any great difficulty; but when the castings are to be employed for electrical purposes, where high conductivity is necessary, the addition of these substances is objectionable, for the electrical conductivity of the copper thus produced is, as a rule, low. The reason for this is that the deoxidisers have also the property of combining with copper, and the remarkable rate in which the conductivity of copper drops when small amounts of impurities are alloyed with it is well known. It is practically impossible to add the deoxidiser in such a way as to eliminate oxygen completely without, at the same time, alloying it to a certain degree with the copper, and the resulting conductivity is then somewhat uncertain and variable. The solution of the problem lies in the use of a deoxidiser which will have no affinity for copper at the melting point of the latter, and which, therefore, can be added in excess with impunity, and this deoxidiser is claimed to have been found by Dr. Weintraub (see page 648 of this issue). The element in question is boron, which lacks affinity for copper, but has a great affinity for oxygen and nitrogen. This element is employed in the form of an amorphous powder which contains as essential impurity only a certain percentage of oxygen, and it is stated that the very first attempt to apply it as a deoxidiser for copper gave a perfectly sound bar with a conductivity of 94 per cent., 0.1 per cent. of the weight of the copper being the amount added. As little as $\frac{1}{10}$ per cent. was proved to be effective, and it was also shown, that the addition of 1 per cent. did not diminish the conductivity or change in any way the mechanical properties of the cast copper. A further simplification can, it is stated, be introduced into the process. The reduction of boric anhydride of magnesium, the first being in excess, gives a product containing magnesium borate, boric anhydride, and boron suboxide, the last being the active agent, and the first two being harmless. The presence of boric anhydride and magnesium borate is, in fact, an advantage, as the addition of a larger mass of material makes the operation easier. It is unnecessary to submit the direct product of the reaction to chemical treatment for the purpose of isolating the boron suboxide; it is only necessary to grind up the mixture into coarse grains and use an amount of it which contains the necessary amount of boron.

The importance of any process which will assist in the production of copper castings without reducing

their electrical conductivity will be apparent to any foundryman, for it means that not only will many of the old troubles be overcome, but castings of this metal will be in a much better position to compete with forgings. The engineer, too, will appreciate the possibility of being able to employ the cast metal with its accuracy and facility for giving intricate designs and shapes without joints, apart from the question of the comparative costs of casting and forging; and granted that the figure of 0.378d. per lb. of copper, which is quoted as the cost of the deoxidiser, can be anything like maintained in practice, the process should find wide application, both for electrical and other work.

The Annual Meeting of the Institute of Metals.

The annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., on Tuesday and Wednesday, January 17 and 18, 1911, when a number of interesting Papers will be presented, including some of an essentially practical character, together with the "Preliminary Report to the Corrosion Committee." It will be remembered that this Committee was appointed some months ago to investigate cases of corrosion of the non-ferrous metals. The Preliminary Report will show the present state of our knowledge of the subject, and will contain suggestions for a research into the causes of the corrosion by sea-water of brass condenser tubes. On the afternoon of January 18 there will be a visit to the works of the Thames Iron Works and Shipbuilding Company, Limited, where an opportunity will be afforded members of inspecting H.M.S. "Thunderer," the new Dreadnought, which is in course of construction in the Company's yard at Blackwall. The Institute has now been founded just two years, and has celebrated its birthday by becoming an incorporated institution. It is now admitted to be firmly established and to be doing really useful work. The Secretary of the Institute, Mr. G. Shaw Scott, M.Sc., Caxton House, Westminster, S.W., will be glad to forward membership application forms and full particulars regarding its work to all interested in the objects and work of the Institute.

British Foundrymen's Association.

At a meeting on Saturday, October 29, of the British Foundrymen's Association, a committee, consisting of Messrs. P. Longmuir (President of the Association), R. Buchanan, H. Pilkington, F. J. Cook, R. Mason, and J. E. H. Allbut, was formed to formulate a scheme for giving a diploma or prize for the best paper given by a member before the Association. At the same meeting four new Members, fifteen Associate Members, and fifteen Associates were admitted to the Association.

Calcium Silicide in Steel Works.

The production of calcium silicide, which is now finding more and more extended use in steel works, is the object of a patent of Mr. Georges Strauss (assigned to Société Anonyme La Compagnie Générale d'Electro-Chimie de Bozel, of Paris, France). According to "Metallurgical and Chemical Engineering," by heating a mixture, in definite proportions, of lime, silica and carbon in an electric furnace, calcium silicide is obtained according to the equation

$$CaO + 2SiO_2 + 5C = CaSi_2 + 5CO.$$

But the direct formation of silicates is a troublesome element n this process. To avoid this, Strauss uses calcium carbide (instead of lime) and metallic silicon (instead of silica) as starting materials. He gives the following equations for the reactions:

$$CaC_2 + 2SiO_2 + 2C = CaSi_2 + 4CO.$$

$$2Si + CaO + C = CaSi_2 + CO.$$

Experiments made with calcium silicide have shown that this metallic silicide is capable of replacing with advantage the aluminium usually employed in steel works for the purpose of preventing the formation of blow holes in steel ingots. The advantages ensuing from such application are, in addition to the economy secured by the very low price of calcium silicide, very great rapidity of reaction and the suppression of the undesirable "shortness" which aluminium communicates to ingot of steel.

The Uses of Cadmium.*

By C. E. Siebenthal.

The chief output of cadmium comes from the zinc-producing regions of Silesia, where it is recovered in zinc smelting. Cadmium has been produced in the United States since 1907 by the Grasselli Chemical Company, of Cleveland, Ohio.

Cadmium is used in metallic form in amalgams and alloys, and the various salts of cadmium are used in the arts, in medicine, and in electroplating. Cadmium, like bismuth, lowers the melting point of alloys into which it enters, but while bismuth forms brittle alloys, cadmium usually makes them more ductile or malleable, though in some cases, as for instance with gold, platinum, and copper, the contrary is true. Cadmium is objected to in spelter, for instance, on the score that it makes brittle brass, not suitable for the finest work, such as cartridge shells, etc. A private communication from a manufacturing firm requiring the highest grade of brass is as follows:—

"Tradition among brass-workers is to the effect that cadimum is extremely deleterious, and that small quantities—as small as three one-thousandths to four one-thousandths of 1 per cent.—seriously detract from the value of brass for purposes of drawing. A meager record kept some years ago does not go to confirm entirely the tradition in regard to cadmium—that is, we were able, although with some slight difficulty, to make use in brass of lead-free spelter, to which we added quantities of cadmium to the extent of five-tenths to seventy-five one-hundredths of 1 per cent.; so under the circumstances we can quite definitely say that, relatively, cadmium is not as serious a detriment to brass as lead. On the other hand, there is no doubt that lead, cadmium, and arsenic, in the order given, have a tendency to make brass brittle and to prevent its drawing properly."

Ingalls, after inquiry among brass makers, concluded that the cadmium content of spelter, as it had not encountered trade objection, was not such as to be greatly deleterious in brass making. He quotes the investigations of a German chemist to the effect that 0.25 per cent. of cadmium in spelter is no drawback, but that cadmium in excess of 0.5 per cent. has an unfavourable effect. The ordinary dental amalgam consists of 26 per cent. of cadmium and 74 per cent. of mercury. Tin or bismuth is frequently added to render the amalgam more pliant under heat. Metal, for stereotype plates, consisting of 50 per cent. lead, 27.5 per cent. tin, and 22.5 per cent. cadmium, is better than the corresponding alloy of bismuth, since it melts at as low a temperature, is harder, and gives a greater number of im-

* From "Mineral Resources of the United States," 1908.

pressions. Fusible alloys, of a number of which the composition and melting point are given in the following table, find use as soft solders for soldering tin, lead, etc., as electric fuses, as fusible plugs for automatic fire sprinklers, etc.:—

Cadmium Alloys.
[Parts by weight.]

—	Cadmium.	Lead.	Tin.	Bismuth.	Melting point (° F.)
Lipowitz's metal	3	8	4	15	158
Wood's metal ..	2	4	2	5	140-160
Fusible alloy ...	2	11	3	16	170
Do. ...	10	8	3	8	167
Do. ...	1	—	2	3	203
Do. ...	1	—	3	5	203
Do. ...	1	—	1	2	203
Do. ...	1	2	1	4	150
Do. ...	2	2	4	—	187
Electrical cut-off	15	20	21	50	—

Lipowitz's metal has a silvery-white colour and a lustre like polished silver, and it can be bent short, hammered, and worked in the lathe. It is used for making casts of small animals and insects, and is suitable solder for tin, lead, and especially for Brittania metal. Wood's metal resembles platinum in colour and is malleable to a certain extent.

The Growth of Cast Iron.

At a meeting of the Sheffield Branch of the British Foundrymen's Association held on November 22nd, the President, Mr. Percy Longmuir, in the Chair, Professor H. C. H. Carpenter, M.A., Ph.D., gave an interesting lecture upon "The Growth of Cast Iron after Repeated Heatings." The fact that certain types of grey cast iron grow very considerably after repeated heatings is now an established fact. Outerbridge's work published in 1905, showed this beyond question, but, like all good pioneering work, it raised more problems than it solved. The exhaustive research carried out by Professor Carpenter in collaboration with Professor Rugan goes far towards explaining the whole problem.

While white cast irons undergo a slight shrinkage after repeated heatings ordinary grey iron can be made to "grow" no less than 60 to 70 per cent. of its original volume. Such a growth may be, in certain cases, highly undesirable and dangerous, as for example with high pressure steam valves, ingot moulds, annealing ovens, kitchen ranges, muffle grids and the like. Such growth is accompanied by porosity in the metal and marked deterioration in mechanical properties.

The very ingenious explanation advanced by the lecturer was that the furnace gases, which were of an oxidising nature, penetrated the fine spaces developed along the graphite plates in grey iron, after heating. The graphite was burned out, silicon converted into its oxide (silica) and part of the iron oxidised. Hence the growth. This meets the fact that only irons with graphite plates present will grow. Silicon tends to make irons susceptible to the treatment solely on account of its action on the carbon. The bars increase in total weight and lose in density as would be expected.

The lecture concluded with some remarks on the chances of obtaining commercial alloys which would not grow. Details of these alloys are to be given at the May Meeting of the Iron and Steel Institute.

Institute of Metals

Birmingham Local Section.

The opening meeting of the Birmingham Local Section of the Institute of Metals was held in the old Birmingham University on November 22nd, under the presidency of the Chairman of the Section, Mr. G. A. Boeddicker.

The establishment of a Birmingham Section marks an important new departure, and an example which, it is hoped, will be followed in other parts of the United Kingdom. The local branch was sanctioned at the Glasgow general meeting of the Institute, and the first officers have been elected as follows:—Messrs. R. M. Sheppard and G. G. Poppleton (joint hon. secretaries), Mr. F. Johnson, B.Sc., (treasurer), with the following as members of the committee: Messrs. J. W. Earle, O. F. Hudson, Vaughan Hughes, E. W. Dobbs, B. J. Mason, A. Spittle, and Professor Turner. It is intended to hold five meetings during the winter session. About eighty members and friends attended this inaugural lecture, including Sir Gerard A. Muntz (President of the Institute) and Professor Turner (Treasurer).

The CHAIRMAN said it was a great pleasure to see so large an attendance, and it showed that the good work already done by the Institute of Metals had been well appreciated. While he was personally satisfied with the work done, they had had a great many complaints, especially by Sir William White and others, that the papers produced were too scientific. That complaint could be met either by lowering the standard of the papers or raising the standard of the members. Obviously the latter was the only course they could take. They needed much more practical knowledge as well as theoretical. In view of what the science of metallography had done for the study of metals, they had decided to ask Mr. O. F. Hudson to commence the work of the Branch with two lectures on "An Introduction to Metallography." One of the objects was to familiarise the new members with the phrascology used in metallurgy and metallography. Those lectures would be followed by two others, devoted mainly to practical questions. The first would be in February, on "Rolling Tube Mill Practice in America," and there would be a further paper in March, on the subject of "Annealing and Annealing Furnaces."

MR. O. F. HUDSON proceeded to deliver his lecture on "An Introduction to Metallography," which was illustrated with limelight views showing diagrams and a remarkably fine series of micrographs mainly of antimony, tin and lead alloys of copper. The Lecturer pointed out that metallography was a comparatively new branch of metallurgical study, of which Dr. Sorby, of Sheffield, might be said to be the founder. That work, however, was not recognised for nearly twenty years. But its great value, especially for iron and steel, was now well appreciated. The speaker proceeded to describe the development and significance of the crystalline structure, tracing the freezing processes, and interpreting the appearances exhibited on the screen. They had found it possible to entirely alter the character of metals by scientifically controlling the thermal changes.

At the conclusion of the lecture, a hearty vote of thanks was accorded Mr. Hudson, and the members were invited to address by post questions to the Lecturer, to be answered at the next meeting, and also to bring specimens of metals which had been found troublesome.

Foundries at the Locomotive Works at Crewe.

The town of Crewe was born with the establishment of—just as to-day the prosperity of its 40 odd thousand inhabitants is mainly dependent upon—the Works of the London & North-Western Railway Company. When the first portion of these Works was laid down in 1843, Crewe consisted of a few scattered farmhouses, whilst to-day it is the site of the largest railway works in the world, where, with the exception of copper tubes and plates, the whole of the operations incidental to the building of a locomotive, including the manufacture of steel, are carried out in their entirety.

FIG. 1.—NEW FITTING SHOP: CREWE WORKS.

The Works were originally established in March, 1843, for the purpose of repairing the locomotives, carriages, and wagons of the Grand Junction Railway, now merged into the London & North-Western system. The portion of the Works which was at that time devoted to the use of the locomotive department soon became too limited for the demands made upon it, and additional space was afforded by the removal of the wagon department from Crewe to Ordsall Lane, Manchester. In 1853 a further addition was made to the Crewe Works by the laying down of a rail mill. In 1857 an amalgamation of the Northern with the North-eastern division was effected, by which the Crewe Works became the centre of the locomotive and carriage departments of the Northern division of the line, the centre for the Southern division being at Wolverton. By 1859, the locomotive department was found wholly insufficient to cope with the growing demands made upon it, and additional space was provided by the removal of the carriage department to Saltley, Birmingham, which took place at the latter part of the year. Some three years later the locomotive department of the Southern division of the Railway was amalgamated with that of the Northern division, and from this time the locomotive works at Wolverton were gradually handed over to the carriage department, additional accommodation being provided at Crewe to take the place of the shops so dismantled.

Perhaps the most important development in regard to the Crewe Works took place in 1864, when the management laid down a plant for the manufacture of Bessemer steel, they being one of the first to introduce the Bessemer process and the use of steel in the construction of locomotives, which material has now, needless to say, almost entirely superseded iron as a constructive material at Crewe. At a later date, open-hearth furnaces were introduced, and gradually took the place of the Bessemer furnaces, the last of which was dismantled some few years ago; at the present time the whole of the steel is produced by the open-hearth process.

The laying down of the steel plant necessitated

the erection of a new works, as the land available at the old works was fully occupied. At this time the Chester and Holyhead Railway passed through the centre of the works, and owing to the increasing traffic, both on the railway and also in the works, it was decided to divert this portion of the line so as to run outside the works, and upon the fork of land between the old and new lines shops were erected which were not inappropriately named "Deviation Works."

The Works, as we find them to-day, comprise three groups of buildings, known respectively as the Steel, Deviation, and Old Works; they occupy a space of some 137 acres, of which about 48 acres are under roof, and find employment for upwards of 7,500 persons,

rams. The ingot moulds are filled as they pass on trucks along the line over which the ladle runways extend at right angles. Furnace doors and buffer shells are also cast direct from the furnaces. The ingots are cast 3 ft. 4 in. long by 14 in. square. They are stripped by one of two hydraulic strippers, conveniently placed adjacent to the reheating furnaces, which latter have a capacity of 24 ingots.

The fitting shop is 463 ft. long by 83 ft. It is served by two 4-ton electric cranes, and is equipped throughout with the most modern machinery for frame-slotting (10 frames being dealt with simultaneously), planing, milling, drilling, etc. The cylinder boring is also done in this shop, the cylinders and ports being bored simultaneously.

The plant in the steel foundry consists of

FIG. 2.—IRONFOUNDRY: CREWE WORKS.

The Steel Works comprises two shops, which contain respectively three 35-ton, and seven 25-ton open-hearth furnaces. The shops are separated by the old Bessemer-converter house, which is now given over to the storage of lining materials, etc., as also for the reception of the high- and low-pressure accumulators. Material for charging the 35-ton furnaces is conveyed to the charging level direct in the trucks up an incline railway and charged by hand. For the smaller furnaces it is raised in bogies by a hydraulic hoist. The seven furnaces are connected by a line of rails along which the bogie runs to the particular furnace requiring a charge. Each furnace is provided with a runway on a level with the tapping hole, carrying a ladle of a capacity equal to that of the furnace, the ladle being manipulated to and from the furnace by two hydraulic

three 10-ton steel melting furnaces, two of which are ranged side by side, and one exactly opposite at the other end of the foundry. The furnaces in the opposite positions are connected by an overhead runway, beneath which the moulds are arranged, and along which a 10-ton ladle is manipulated by chain operated from a hydraulic capstan; this ladle serves the two furnaces, and the casts are made as it passes along the track. The third furnace is provided with a similarly elevated ladle, but in this case the runway is short, and castings are made in the usual manner. Material is conveyed to the charging level by hydraulic hoist, and charged to the furnaces by hand. There are the usual auxiliaries, including a coal-fired annealing furnace and a core-drying oven, which last occupies a central position. The castings embrace such

articles as wheels, motion plates, brackets, horn blocks, axle boxes, and brake hangers.

In the iron foundry moulding machines are very largely employed. The floor is served by two 10-ton electric cranes and numerous hydraulic and hand cranes. There are four cupolas, the larger of which have each a melting capacity of 4½ tons, and the smaller a melting capacity of 35 cwts., per hour. For the larger cupolas the wagons containing the material are raised bodily to the charging level by hydraulic hoists. Adjoining the main building is the chair foundry, which is devoted entirely to the recasting of the large number of chairs required for the permanent way. It is served by a cupola with a melting capacity of 35 cwts. per hour.

On the north side of the buildings are the pattern shop and the pattern stores. The feature of these buildings is that in their construction old rails have been very largely employed; in fact, the supporting pillars consist entirely of old rails fitted into cast blocks at the floor and provided with cast-iron shoes to carry the roof girders, presenting a very light and neat appearance.

The brassfoundry, which is equipped with two large melting furnaces and also a number of crucible furnaces, gas for firing which is obtained from two producers just without the building, the signal shop, paint stores, and new fitting shop, complete the auxiliaries to the Steel Works.

Gas for the steel furnaces is supplied by a battery of 58 "Wilson" producers fitted with water-seal bottoms. These are ranged in two lines on either side of the permanent way, the wagons of coal being drawn up between them. The power-house for the Steel Works contains seven "Belliss" compound sets and three "Willans" sets coupled direct to "Crewe" machines, the "Willans" sets being used for lighting purposes only.

Jobbing Foundry Methods.

By "T. H. H."

The writer wishes to call attention to the obsolete methods adopted in some of our foundries, and the complete lack of any originality in the way the work of some of these establishments is carried out. Jobbing work calls for greater skill on the part of the workman, and a higher degree of originality on the part of those in authority, than does repetition work. Although not lending itself to be treated as repetition work, yet jobbing work must be moulded on the best and quickest lines available, to ensure good results and a clear profit. Jobbing work in many of our foundries may take the form of anything from a hanger to a complicated cylinder of some tons in weight. This means that one cannot keep a supply of boxes and tackle on hand for every job; nor can a special box be made to suit every piece of work on hand. But a lot of the shiftless methods adopted may be easily superseded by easier ways than are at present in use. It is here that this class of work calls for more skill and originality in the methods of moulding; and in some foundries a little more consideration for the moulder, and greater attention paid to the necessary tackle and material to carry out the various stages of operations would be well repaid in results. There seems to be a rooted idea in the minds of many foremen, and also those in higher authority, that a moulder can produce his castings without any tackle whatever; with a box that is ready to fall in two, lifters shapeless and short, and sand for facing which scabs if it sees water a mile off. A good box is not only worth the trouble of making and the expense incurred, but it facilitates the moulding, takes less lifters, and, what is more important, is safer. Just as the skilful engineer cannot produce his machined castings and complicated machines without a plentiful supply of good tools, neither can a moulder produce sound castings, true to pattern, and in reasonable time unless he also has the necessary tools on hand. What is it that causes those in authority to withhold consent for the material and tools necessary to carry out jobs properly? It is the idea that "it's only a foundry," and anything will do? If so, the sooner such ideas are knocked on the head the better. Surely it cannot be on the score of economy, because if it is it is false economy. If a moulder needs a certain number of gaggers of suitable length, and he finds that he has to use unsuitable ones, and twice as many, and more trouble to place them, where is the economy? Again, a moulder is told to fire a job—that is, to dry it—and to do so he has to use old buckets, with the bottoms out; many of them won't stand up, no heat of any account is generated, they have to be repeatedly shaken up and coked, and then he finds his job only half dried. Whereas a few good fire-baskets made of good strong material, would dry the job in half the time, with less trouble, and at less cost.

The moulder to-day does not lack originality, he is more skilled and better able to do his work than his predecessors; but I question whether the methods he has to employ to-day are any better than his predecessor used.

The be-all and end-all of many foundries is to get a job in and "get it out." Insufficient crane power, unsafe working conditions, and lack of security are a great trouble to the moulder; and yet many times he is only just working inside the lines of safety. A man is given a piece of work to make, say, requiring a hole 8 ft. square and 4 ft. deep. This he may have to dig through hot sand, from where a hot casting has just been taken out. Hot and perspiring, he is still expected to have his wits about him and to know what he is doing, but how can a moulder "feel fit" after one or two hours of this sort of work? Would it not be far better to have the hole dug out by labourers? It is more economical, can be done just as well, and leaves the moulder in a better condition to carry out the more skilful part of the operation.

When placing a bed, a moulder often finds a difficulty in getting levelling strips good enough for his purpose; he will probably have to hunt up and down the shop, and then only find warped, and damaged strips. Cast-iron strips of suitable length, machined true should be provided, and kept in a suitable place when not in use. Gaggers, lifters, grids, hooks, bolts, and wedges all can be left to the care of a labourer to clear up after every job is cast, to be placed in a convenient box. Facing sand should also be kept close at hand in a suitable box, either formed of iron plates or planks; this should be kept filled and moistened, so that no moulder would be required to go to the extreme end of the foundry for his sand. A lot of unnecessary work done by moulders can be easily done by labourers; it all leads to a more methodical way of working. A plentiful supply of tackle, and that at hand, means more economy in production in the long run; and all the lifting appliances, etc., necessary for safe work, assist in the successful running of a foundry.

The Present Status of Electric Steel Processes.*

By Professor B. Neumann.

Last year 17,773 tons of electric steel were made in Germany, mostly fine qualities; but the electric furnace is also making "tonnage" steel, and furnaces of 25 tons' capacity are quite possible to build. The following are some of the latest improvements in electric steel practice:—

Héroult Furnace.—The author gives an account of

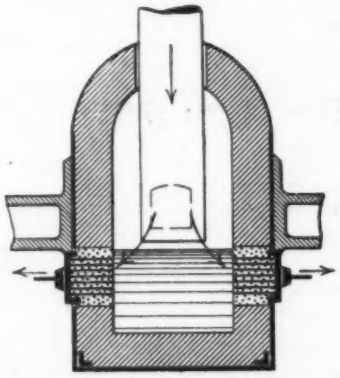

FIG. 1.—THE LEVOZ ELECTRIC FURNACE.

the South Chicago plant, a description of which has already been published.

Stassano Furnace.—The hearth and side walls are now stamped of burnt dolomite; only the roof is made of magnesite bricks. The roof lasts four to six weeks; the hearth lasts three to four weeks, producing 70 to 100 tons of steel. These figures are for making four heats in 12 hours, and not running nights. When melting scrap and producing steel similar to soft Swedish iron the power used is 750 kw.-hours per ton.

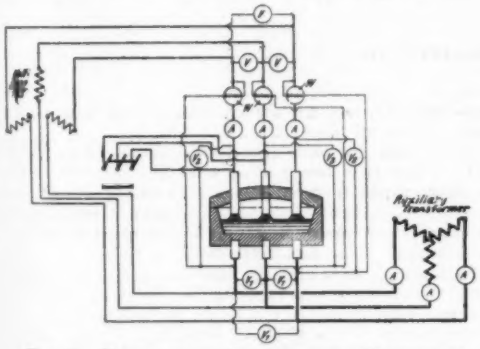

FIG. 2.—DIAGRAM OF CONNECTIONS, NATHUSIUS ELECTRIC FURNACE.

The bath is deoxidised by silicon and manganese. The rotating furnace has been replaced by a simple tilting construction, which is much cheaper and answers generally quite as well.

Girod Furnace.—The 12-ton furnaces at Ugine are now being charged with 15 to 16 tons of scrap, and 14½ tons are tapped from them with much better power efficiency.

Chaplet Furnace.—This is used at Allevard; it runs with the same manner of heating and course of the current as the Girod furnace.

Keller Furnace.—This has the whole hearth made conducting by a multitude of small metallic conductors; it has proved itself quite permanent in use. A 3½-ton furnace of this kind is being installed at Burbach in Germany; this form is preferred to the two-electrode Keller furnace.

Levoz Furnace (Fig. 1).—The furnace body is like a Bessemer converter, but with an electrode passed through the roof, and conductors like Keller's hearth built into opposite sides beneath the level of the

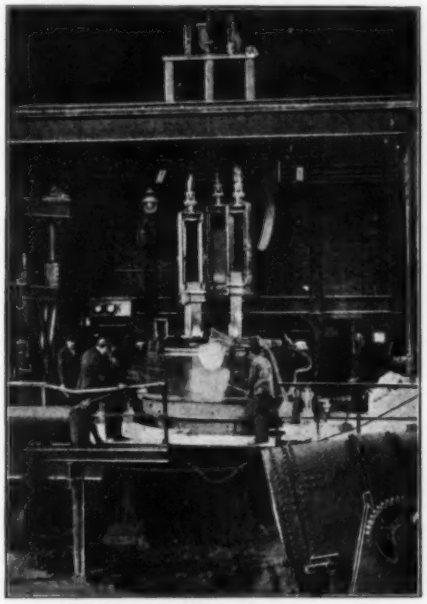

FIG. 3.—FIVE-TON NATHUSIUS ELECTRIC FURNACE IN OPERATION.

bath. The whole is mounted on trunnions. This furnace is being tried at a Belgian works.

Nathusius Furnace.—This combines the surface heating of the Héroult furnace with hearth electrodes. Three electrodes of a three-phase system pass through the roof; three steel electrodes, likewise connected with the three-phase system through transformers, are embedded in the hearth, but are covered by the hearth material. As the hearth becomes warm it becomes conducting, and a current of high voltage and small amperage can be sent between these three bottom electrodes, and so the hearth heated to any desired degree (Fig. 2). V represents the secondary of a step-down transformer, V_1 that of an auxiliary transformer for heating from the bottom electrodes.

The bottom electrodes can also be connected in series with the upper electrodes, the furnace then working like a Girod furnace except that the hearth

* Paper read before the recent International Congress at Düsseldorf.

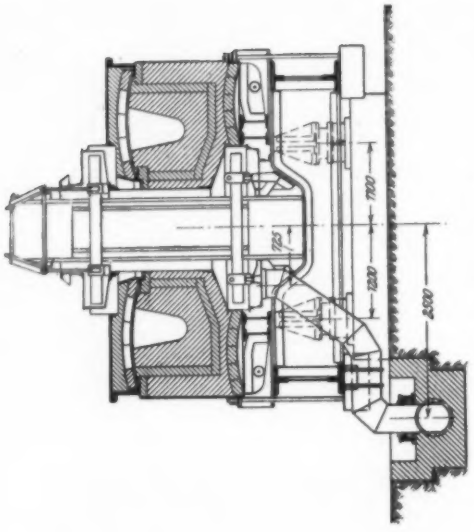

FIG. 5.—CROSS-SECTION.

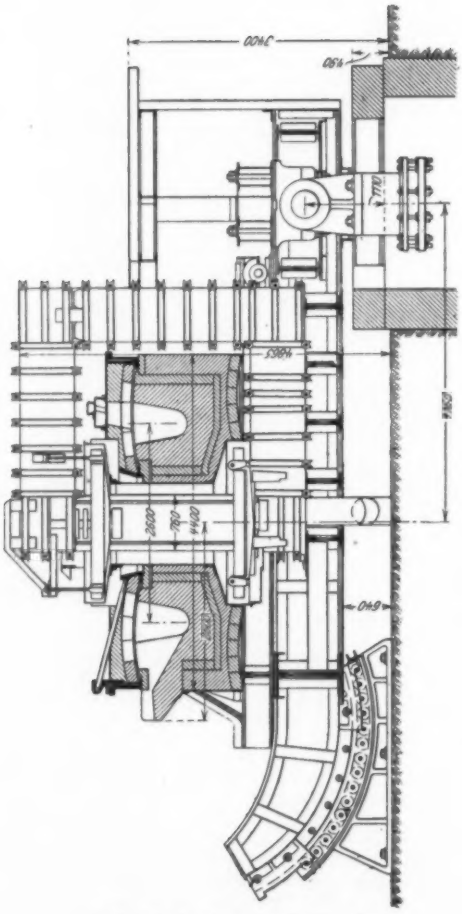

FIG. 4.—LONGITUDINAL SECTIONAL ELEVATION.

THE FRICK ELECTRIC FURNACE.
(*Dimensions in Millimetres.*)

is highly heated by the passage of the current through it. The bath is kept in active motion by the magnetic field created by the current. If the bath is desired to be left standing, the three upper electrodes can be lifted up and the heating left to the bottom electrodes only.

A 5-ton furnace on this system has been working satisfactorily for a year at the Friedenshütte in Upper Silesia (Fig. 3). The upper electrodes receive 550 k.v.a. at 100 volts; the lower set, 150 k.v.a. The furnace is 9 ft. in diameter outside, and 7 ft. inside, with two doors and a pouring spout. The electrodes are 80 in. long by 10 in. square, and are suspended from beams independent of the furnace, so that the latter stands quite free. The roof is of high-alumina firebricks; 5 to 5½ tons of fluid basic-Bessemer steel are treated for 3½ to 4 hours, using 300 kw.-hours per ton of steel. The product is dead soft steel, with 0.002 to 0.017 per cent. phosphorus, 0.005 to 0.020 sulphur, and 0.05 to 0.06 per cent. carbon.

Kjellin Furnace.—This simple induction furnace has been built up to 8½ tons' capacity. It is not suited for refining purposes, only for melting, and alloying of special steels.

Röchling-Rodenhauser Furnaces.—These are now working up to 8 tons' capacity, and a 16-ton furnace is contemplated. This was the first furnace to make electric steel for rails and railway material. The furnaces are started by laying iron rings in the gutters, and pressing the scrap tightly about them; the latter sinters and soon takes part in conducting the current. Moulded dolomite bricks are now used to shut off the slag from the central compartment or reservoir, and so keep the iron in the induction rings clean from slag. The bottom of the central reservoir has also been provided with elevations which contract the section through which the electric current flows and produce locally high heating.

When standing over Sunday, it was usual to keep enough current on the furnaces to keep the contents melted; now the furnace is charged, the doors luted tight and the current shut off entirely. After 30 hours' standing the current is put on again, and in four to six hours the furnace is at running heat.

The secondary current which is sent through pole plates buried in the hearth material is, when starting, run by a higher voltage, in order more quickly to warm up the hearth and make it conducting; as soon as this is attained, the lower voltage is switched on. When cold scrap is being worked, as much as 2 or 3 tons are charged at once into the 8 ton furnace, the doors closed, and the whole melted down at once without opening the furnace. This has been found to take less energy than the continual feeding-in of the scrap in small quantities.

The Frick Furnace (Figs. 4 and 5).—The Fried. Krupp Company has put up a 10-ton furnace of this pattern, which is usually run with an 8½-ton charge, of which 6½ tons are tapped. The heat lasts 6½ hours. It is used only for melting down high-quality material to fine steel; the material being charged ¼ ton at a time for 4½ hours, and the last two hours being used for heating up to a dead melt. It is an induction furnace which differs from the Kjellin only in the arrangement of the primary windings, which are flat and arranged over and under the melting ring. The outer diameter is 14 ft.; ring, 9 ft.; breadth of bath, 16 in.; primary current, 5,000 volts and 265 amp.; frequency, 5 per second; power-factor, 0.528; power, 590 kw.; calculated amperes in the bath, 52,000; calculated resistance of bath, 0.0002 ohm.; power used, 617 kw.-hours per ton of steel. Of the 590 kw., 187 is used to keep the furnace up to heat (to supply radiation and conduction) and 403 for melting and heating purposes; therefore, electro-thermal efficiency $\frac{403}{590}$ = 68 per cent.

The level of metal in the bath is displaced only 5 degrees from the horizontal, while in the Kjellin furnace it sometimes reaches 24 degrees; the metal in the induction rings rolls actively, which gives a good mixture, but makes it difficult to keep the bath covered with slag. In eight weeks this furnace made 180 charges, yielding 1,150 tons of fine steel. The campaign was stopped because of injury to the roof; the hearth was uninjured.

Analyses of the steel made show the following properties: —

C	Si	Mn	P	S	Tensile strength Kg. sq. cm.	Tensile strength Lb. sq. in.	Elongation. %	Contraction. %
0.8	0.23	0.30	0.020	0.024	50.4	72,000	27.5	65
0.77	0.15	0.40	0.013	0.015	83.7	119,000	16.6	46

The Hiorth Furnace (Figs. 6 and 7).—This has been running in Norway, at Helleren on the Jössingfjord, since December, 1909. It has two rings, like the Röchling-Rodenhauser furnace, with a hearth in the middle. The primary windings are divided into four, which are arranged in flat form above and below (embedded in) the two smelting rings. This results in the maximum electrical transformation efficiency and the smallest dispersion losses. The lower embedded windings are cooled by water or air; the upper ones, in the air, cool themselves, and are movable so that they can be lifted up out of the way. By this arrangement the smelting ring can be enlarged to any extent desired.

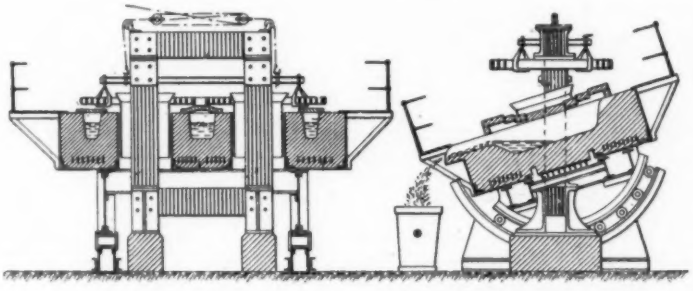

FIG. 6.—SECTIONS OF HIORTH ELECTRIC FURNACE.

The magnet frame is fixed; only the furnace body with the lower windings is mounted for tilting. The furnace holds 5 to 6 tons; the power-factor is given as 0.7 to 0.8, and the furnace is said to work well, both electrically and metallurgically. The process is only the melting together of pig-iron and scrap. Two analyses and tests made of the steel in Stockholm show: —

			C.	Si.	Mn.	P.	S.
(1)	...	...	0.56	0.14	0.61	0.031	0.01
(2)	...	...	1.00	0.16	0.56	0.026	0.015

			Elastic limit. Kg.per sq. cm.	Elastic limit. Lbs. sq.in.	Tensile strength. Kg.per sq.mm.	Tensile strength. Lbs.per sq.in.	Elongation. %	Contraction. %
(1)	...	...	38.5	55,000	70.5	100,700	12.3	31.7
(2)	...	...	46.4	66,300	97.6	139,400	2.3	2.3

Ischewsky Furnace (Fig. 8).—This is neither an arc nor an induction furnace. It consists of a rotating cylinder with radial bricks *a* between which pass iron electrodes *b*. A 1-ton furnace is in operation, making two turns per minute. The current enters by the brushes A and leaves by the brushes B, which connect with brass springs *c*, *c*, making connection with *b*, *b*. The current passes partly through the bath and partly through the material of the roof. If no metal is present, the current passes through the copper strip *e*, *e*, placed beneath the furnace.

The interior of the furnace is first heated by coke, and some soda put in to make a thin conducting inner layer. The 1-ton furnace operating in the Urals has 36 iron electrodes 44 in. by 12 in.; the inside space is 2 ft. 6 in. diameter and 4 ft. long; the walls are 1 ft. thick. It is lined with acid refractory, and the current used is 600 amp. at 550 volts, taken in by four brushes.

In conclusion, Professor Neumann says concerning the development of the electrical manufacture of steel: —

"The first stage of the development was in the production of high-priced material, making sharp competition with the costly crucible process. Since the electric furnace furnishes much larger quantities of uniform material, it is not dependent on the purity of the material charged; it works cheaper, and deoxidises the metal at least as well as the crucible will; it enables the adjusting of the carbon, silicon, and manganese much more accurately, and additions can be made such as it is impossible to make in the crucible. Further, high-quality material can be made by refining scrap and other impure material, which is a field in which the crucible cannot compete.

"For some time, however, the second stage of the development of electric steel has begun, viz., the use of the electric furnace for producing a mean quality of steel to fill in the gap between ordinary steel and crucible-quality steel. The electric furnace can be used in combination with the previous steel refining processes to still further refine their product at quite small cost; there is thus produced a nearly sulphur-and-phosphorus-free product, free from segregation, and of great homogeneity, which is particularly suited for high-class rails, tyres, axles and springs.

"According to experience the present used steel refining processes were not used at first because of the cheapness of their product, but because of its superior quality; the electric steel refining will follow the same course. When once a better quality of steel can be furnished for a slightly higher price, this quality is soon used for other and more extensive applications. The electric furnace is well on the way to produce steel in enormous quantities; in the near future it will become a common auxiliary in steel works to supplement the ordinary refining processes, whose entire product will be thus further refined.

"While high-quality steel is mostly made from cold charges, the production of a middle quality in large quantity will require the transfer of fluid metal from converters or open-hearth furnaces, since only in this way is it possible to use the minimum quantity of electrical energy. Since desulphurisation in these ordinary furnaces is always incomplete, the advantage of an electrical refining is self-evident. In acid-lined open-hearth or Bessemer furnaces no sulphur or phosphorus at all are eliminated, and the metal from these is further refined in the electric furnace with the greatest advantage. The Bessemer converter may thus find new life in competing with the open-

hearth process. It is always possible to produce a high-quality steel in the electric furnace from any kind of raw material, and this will probably make Germany independent of the importation of special Swedish raw material, a national economy which is very important.

"A large quantity of electric steel is being made up into steel castings. The electric furnace is a convenient melting apparatus in quite small foundries which are not large enough to run a Bessemer or a

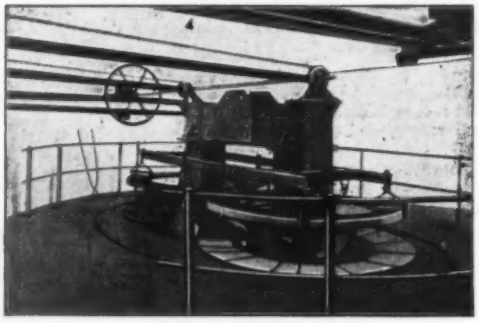

FIG. 7.—THE HIORTH ELECTRIC FURNACE.

small open-hearth furnace. It will also be useful in malleable casting foundries. Why could not fluid cast iron be brought directly from the blast furnace of a mixer or a cupola, put into an electric furnace, and there kept hot and receive necessary alloys until its composition was just what was desired, and then cast at just the proper temperature? This keeping hot need only require 50 kw. per ton of metal, so that the certainty of obtaining the exact composition required and of casting at the right temperature would in many cases more than repay the cost of the electrical heating.

"A recent unique application of the electric furnace can be here mentioned. The Eicher-Hütten-

FIG. 9.—ELECTRIC FURNACE PLANT AT DOMMELDINGEN.

Verein, Le Gallais Metz & Cie., at Dommeldingen, convert pig-iron directly into steel in a gas-heated, 20-ton tilting Wellman furnace and three 4-ton Röchling-Rodenhauser induction furnaces (Fig. 9). The Wellman furnace acts as an oxidising mixer. The iron in the Wellman furnace is oxidised down to about 0.26 carbon, 0.082 phosphorus, and 0.03 sulphur. This is drawn into the electric furnaces and there refined to the desired quality, using 350 to 390 kw. to a 3½-ton furnace, in about two hours for steel for castings and 3 to 3½ hours for best machinery steel. Some analyses are:—

	C.	Si.	Mn.	P.	S.
Pig-iron	3.50	0 60	1 20	1 80	0.12
Mixture in Wellman furnace	1.62	—	0.66	0.46	0.045
Tappings from Wellman furnace	0.26	—	0.30	0.08	0.030
Steel castings	0.35 0.40	0.25	0.50	0.020	0.010
Hard fine steel	0.85	0.23	0.26	0.011	0.009
Chrome steel Cr. 0.87	1.17	0.19	0.16	0.014	0.009

"The above review gives an idea of the extension of the field of the electric furnace. With such a young branch of industry it is naturally not to be predicted what further possible applications may develop. So much, however, is sure, that the introduction of the electric steel furnace has opened up a new era of refining to high-quality steel, at a moderate cost."

Crucible Steel Manufacture in France.

We learn from Paris that a company is in course of formation in that city with a capital of £20,000, and the title, La Société des Forges et Aciéries de Sheffield-France, with the object of establishing in the neighbourhood of Paris a crucible steel plant and a battery of forging hammers. According to the prospectus, the plant "is to be an exact

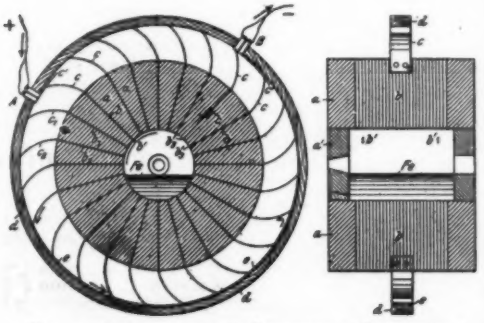

FIG. 8.—DIAGRAMMATIC SECTIONS OF ISCHEWSKY ELECTRIC FURNACE.

reproduction of similar and most improved installations in Sheffield. The construction and working of the furnaces, as also the steam hammers, will be carried out by Sheffield engineers who have been responsible for the most recent plants in that town. The *personnel* necessary for the manufacture of crucible steel and for the production of the forgings will be obtained from Sheffield. The material for making the crucibles, the coke, the furnace tools, as also the steam hammers, and the necessary material will also all be drawn from Sheffield, in order to ensure the production of steel equal to that which has given Sheffield a universal reputation." The new undertaking, the moving spirit of which is M. Enri. J. Burtal, an engineer-metallurgist, who is stated to have studied the subject of crucible steel manufacture in several works in Sheffield, is apparently the outcome of the new French tariff, under which an increased duty is imposed on special steels of foreign manufacture.

THE question of a fitting memorial to the late Sir Alfred Hickman, who was intimately connected with Bilston for a large number of years, is now under consideration. It will probably take the shape of a park for the township.

Notes on Contraction.

Before a meeting of the Lancashire Branch of the British Foundrymen's Association, on November 5, Mr. Frank Andrew read a Paper on "The Moulder and Chemical Analysis; with some Notes on Contraction." The latter section of the Paper we reproduce herewith.

The majority of moulders do not always understand the difference between a good or a bad design, their knowledge being limited to the class of work to which they have been accustomed. One accustomed to moulding arm pulleys will know that unless he bares the boss, when that is large in proportion to the arms, one or more of the arms is likely to break. If the tread of the rim is narrow and light in section, this is also liable to fracture. Many would give as the reason for the fracture that the heavy boss in shrinking had pulled at the arms, whereas it is the arms which in cooling quicker contract more than the boss and exert a pull on it. While the boss remains fluid this contracting of the arms is allowed to take place without any apparent bad effect. When the boss solidifies any contraction which occurs will cause more or less tension in the arms, this tension increasing until the normal temperature is reached. If the iron is of a hard nature an arm may break soon after solidification of the boss, either near the

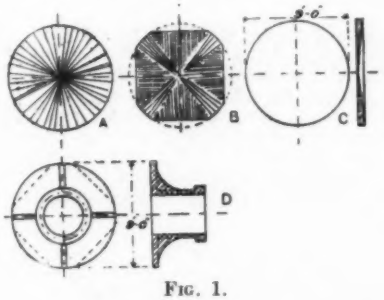

Fig. 1.

boss where the metal is not quite hard, or, if the arms are thinner in some parts, the fracture will occur there. With a softer iron the separation of graphite may have a compensating effect on the contracting arms, which may remain whole, or may fracture during dressing. To overcome these contraction effects the arms are in many cases curved, the idea being that the curve takes up the contraction, the tendency being for the curve to be reduced. But it is quite a common thing for these curved arms to break. Therefore, this curve is not as effective as it ought to be, and the amount of contraction taken up by it is very little; for if the arm of a pulley which has broken, even after being in use be examined, it will be found that the two ends are not quite close to each other. This space between is caused by a reduction in the tension of the other arms, allowed by the broken arm. If there were no other drawbacks, perhaps straight arms slightly dished would be worth consideration. Reference has been made in books to a plate 9 ft. in diameter, which if cast without holes and then cut radially to the centre from one edge, would show an opening 1¼ in. wide at the circumference. If this plate was not very thick, the writer would expect it to be very crooked, unless it was uncovered in some places while still in the mould and red-hot. If baring were not done the opening might be more than 1¼ in. wide.

In castings of which such a plate forms a part, this effect might have a serious result, as for instance in the form of casting shown at D, Fig. 1, which consists of a circular plate with a hole in the centre, and to which a portion of a cylinder is attached, with the four radial brackets for strengthening purposes. To reduce the effects of crystallisation to a minimum in the plate of this casting it is suggested that a

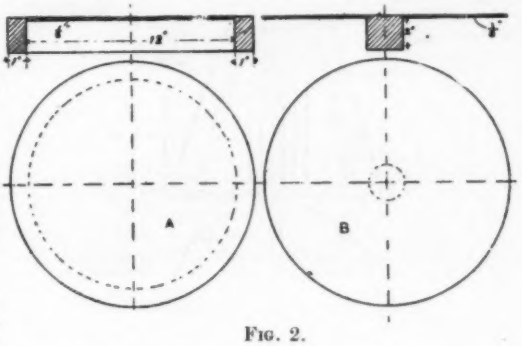

Fig. 2.

piece be taken off at each of the four sides as shown by dotted lines. If the direction which the crystals will take be noted, according to the law that they group themselves with their principal axes perpendicular to the cooling surface, the result is that either the amount taken off is very small, in which case there is not much effect either way, or if the amount is very large, the shape approaches to that of a square with the resulting diagonal lines of weakness between the different set of crystals. This would require that baring be done diagonally or above the brackets. The outside edge of this plate really acts as a radiator between the brackets, and in each the centre may have become black, while the boss and the plate above the brackets remain red. By taking off the portions at the dotted lines, the amount of radiator is reduced and more equal cooling is obtained. To keep the shape of a large circular plate good, without putting either holes or slots in the centre, either the outer edge must be thicker than the centre, as shown exaggerated in C, Fig. 1, or the

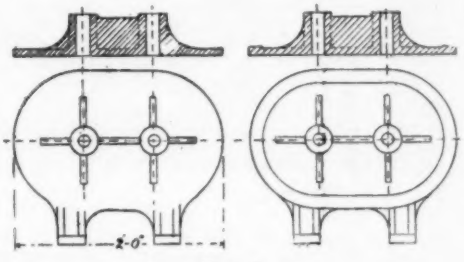

Fig. 3.

centre must be made to cool as quickly as the outer edge, by baring at the middle and well covering up the outer edge with sand and hot heads.

Extremes of thickness at the edge and middle are shown in A and B, Fig. 2. More than ordinary care would be required in producing a casting of either form. The two combined would produce a form of plate wheel, which would be liable to crack across

the plate, due to the differences in thickness being too great.

In the first of the blower ends shown in Fig. 3 there is a tendency to twist, prevented somewhat by the rib shown between the two bosses. This twisting will, however, occur in spite of the rib, and on account of the resistance of the rib sometimes cause the plate to break across the middle between the bosses. In this case the outer edge of the plate cools first, tension is produced, and twisting or fracture occurs at

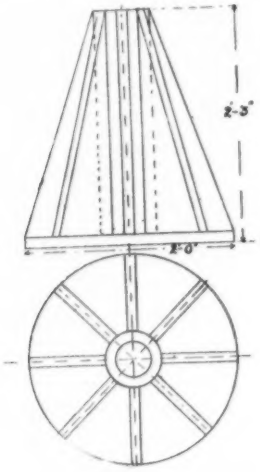

Fig. 4.

the place where there is least resistance—between the bosses. If the outer edge was thickened by means of a facing all round at the back, the tendency for the plate to twist would be reduced, by producing a more equal rate of cooling.

In the short pillar shown in Fig. 4 there are eight brackets for extra support to the upright. When making some castings of this description, it was found that the bottom side, which should be flat, would invariably be convex, and as this face was machined and had to rest on a stone foundation, extra facing had to be done in the middle in getting level with the outer edge. This extra machining meant that the pillars

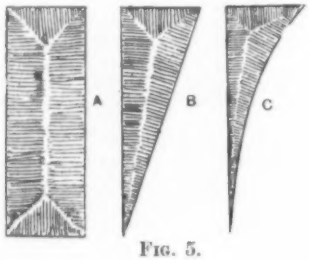

Fig. 5.

came short of the length they were required to be. At first sight the cause of the convexity appeared to be in the moulding, but although the top part when tried with a straight edge showed true, the castings still came out round. It might appear that the top box was sprung in the centre by the strain produced during casting, assisted by the expansion of the core in the centre. This was hardly likely to occur, as the top box was 6 in. deep and a little over 2 ft. wide and fairly strong, so that any expansion of the core would have been more likely to raise the part immediately above it only. Actually there was no fin over the centre core, nor did it protrude through the casting.

In the three examples A, B, and C, Fig. 5, giving the directions of the crystallisation in plates of such forms, it will be found that B has the same shape as each of the eight brackets on the pillar in Fig. 4. It is probable that these brackets on the slant edge in contracting, pull the outer edge of the circular disc downwards, with the result mentioned. The slower cooling of the central portion (the shorter length and therefore with the smaller amount of contraction) of the inside edge of the brackets, and the retarding effect of any expansion of the core in the direction of its length, would keep up the centre,

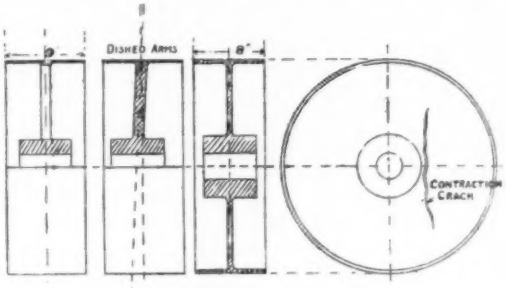

Fig. 6.

whilst the outer edge would be pulled down. If the free outer edge of the brackets was curved, that is, a portion of the brackets removed as shown in C, Fig. 5, the cooling effect of these radiators would be reduced, without the strength being impaired. In cases where the distance between the brackets was great, the contraction of the plate between would have to be reckoned with as in the case of D, Fig. 1, or extra thickness provided in the form of a facing all round.

Another example of unequal contraction is shown in Fig. 6, which shows a plate pulley. Cracking occurred during dressing, and confirms what was said respecting Fig. 2, though the quality of the iron would also influence results.

In Fig. 9 is represented an American example of the effects of expansion and contraction which seems

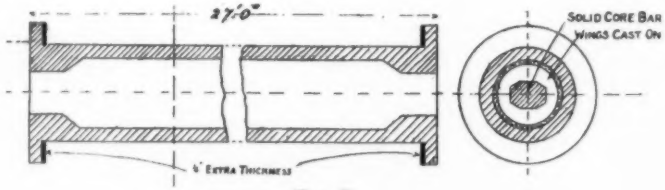

Fig. 7.

remarkable. The particulars given are that the casting was a pillar 27 ft. feet in length. Contraction allowed was $\frac{1}{10}$ in. to each foot, a total of 2.7 in. for the length, $\frac{1}{4}$ in. on the face of each flange for facing and $\frac{1}{4}$ in. at the back of each flange for safety. The core was of green sand on a cast-iron arbor or core-bar with wings all along the length, excepting at the ends where the core narrowed down. The morning after casting, while still at a cherry-red heat, a measuring rod showed the casting to measure nearly 4 in. longer than the required casting. When cool the contraction

allowed for was found to have been correct, leaving the extra ¼ in. at each end for facing.

Length of mould	Finished casting ...	27 ft.	0 in.
	Facing		0.5 in.
	Contraction		2.7 in.
Total		27 ft.	3.2 in.
Length of casting (cherry red heat)		27 ft.	4.45 in.
Length of casting (cold)		27 ft.	0.5 in.
Contraction from cherry red to cold ...			3.95 in.

The explanation given is expansion of the heavy core-bar, which on account of the choke at each end caused the casting to assume the length given. But the question arises, if the choke at each end caused the pillar to increase its length when the core-bar expanded, why did it allow the casting to contract 2.7 in., this 2.7 in. contraction having to take place on the original length of core bar?

Vanadium Cast Iron for Locomotive Cylinders.

Cast iron may be regarded as a more or less impure steel, containing, in addition to the usual elements present in steel, a comparatively large quantity of graphitic carbon interspersed throughout its structure in the form of granules, flecks or plates. The graphite destroys the continuity of the metal. In consequence the limit of strength of cast iron is low as compared with steel.

The benefits which accrue from the incorporation of small percentages of vanadium with cast iron, especially in chill and cylinder castings, are very great, even if they are not so spectacular in their nature as those obtained in steel. Vanadium not only cleanses the cast iron from oxides and nitrides, but also exercises a very strong fining effect on the grain of the iron, with the result that porosity is eliminated and sound castings are produced. Strength, resistance to wear and rigidity are all increased by the addition of vanadium to grey cast iron, while the vanadium martensites are much tougher than ordinary martensites. In the case of chilled cast iron, vanadium produces a deeper, stronger chill, and one less liable to spall or flake. Chilled iron rolls containing vanadium have shown remarkably increased resistance to wear in service.

As a result of two years' test on a pair of cast-iron cylinders made of vanadium cast iron, the New York Central Railroad Company specified vanadium cast iron for the cylinders of 183 new locomotives built during the past eight months. The pair of cylinders under test gave upwards of 200,000 miles, with only microscopical wear, whereas ordinary locomotive cylinders will show about 1-32 in. wear per 100,000 miles. These locomotives were built by the American Locomotive Company, and comparative tests have been made between the iron containing vanadium and that to which no vanadium was added. The averages of ten consecutive comparative tests are as follows:—

	Transverse strength. Pounds.	Tensile strength. Pounds.
Ordinary cast iron ...	2,130	24,225
Vanadium cast iron ...	2,318	28,728

The transverse tests were made on 1-in. square bars, 12 in. between supports; the bars were machined all over, and consequently were absolutely comparable, as is not the case with bars tested as they are cast. The tensile tests were also of machined bars. In machining the vanadium cast-iron cylinders, the effect of the vanadium was noticed in the machining qualities of the iron; the chips were not so short, were tougher, and showed considerable springiness.

The use of vanadium in cast iron will doubtless find its greatest field in engine cylinders, both gas and steam, where it will be of great value in increasing the life of the cylinder through its effect on the wearing qualities of the iron.

Tests of vanadium in malleable cast iron have been reported as satisfactory in every way, the fibre of the iron showing much cleaner and the tensile strength being improved about 12 per cent. The castings were also very much stiffer than ordinary malleable castings.

In applying vanadium to cast iron, it must be remembered that nothing like the heat of molten steel is available; consequently one should use a finely-crushed or powdered alloy of a low melting point. As the melting point depends directly upon the percentage of vanadium contained in the alloy, a ferro-vanadium containing under 35 per cent. vanadium should be used. If the iron to be vanadised is melted in the air furnace, the procedure is a very simple one; after the charge is melted and 15 to 20 minutes before tapping, the ferro-vanadium is added and the bath well stirred or rabbled.

Where the iron is melted in the cupola it is necessary to add the vanadium to the ladle, and, as the amount of heat available for dissolving the ferro-vanadium is limited, the iron should be tapped out as hot as possible, and a ladle used that has just been emptied, in order to conserve as much heat as is practicable. After the bottom of the ladle is covered with a few inches of iron, the finely-crushed or powdered alloy is added by sprinkling it on the stream of iron as it flows down the spout to the ladle. In this way advantage is taken of all the available heat, and there is also the mixing effect of the stream as it strikes the iron in the ladle. After the vanadium is added the contents of the ladle should be well rabbled and allowed to stand a few moments before pouring, in order to ensure thorough incorporation and complete reaction.

In the case of cupola iron, with its limited available heat, it has been found that the addition of 0.10 to 0.12 per cent. vanadium is all that should be attempted ordinarily; while in the case of high-grade air-furnace iron, with its reserve of available furnace heat, the addition of 0.18 per cent. to 0.20 per cent. is advisable and readily made.

The analyses of a great many tests show that about 70 to 80 per cent. of the vanadium alloys with the iron, the remainder being used up in cleansing the iron from oxides and nitrides. In remelting cast iron which has been vanadised, most of the vanadium is necessarily lost, owing to the very strong oxidising conditions under which the iron is melted. The effect, however, of the small amount of vanadium remaining in the remelted iron is apparent in the texture of the grain and its consequent freedom from porosity.

Cast Copper of High Electric Conductivity.*

By Dr. E. Weintraub.†

The production in the foundry of pure copper castings mechanically sound and possessing an electrical conductivity comparable to that of pure forged copper has been an important problem ever since the development of electrical machinery and apparatus. The literature as well as the patent files are replete with descriptions of methods for accomplishment of this result. Secret compositions, warranted to give high conductivity copper, were and are being sold to foundrymen, and there are but few foundry foremen to be met with who do not claim to have some time or other obtained the desired result by adding "phosphorus" or similar material. Obstinately, however, the casting of high-conductivity copper refused to make its entrance in the foundries, and it may be assumed that there were good reasons for it.

The cause of the difficulty of producing sound pure copper castings has been sufficiently well understood for a long time. Molten copper has the property of dissolving gases such as oxygen, and of setting a part of these gases free on cooling. This produces pin holes and even big cavities. The casting obtained is, therefore, mechanically unsound and has naturally a low electrical conductivity.

The elimination of these dissolved gases presents but little difficulty. It is sufficient to add one of the well-known deoxidisers such as zinc, magnesium, phosphorus, etc., in small quantities to bind the oxygen chemically. Copper castings free from blow holes are thus easily produced. The electrical conductivity of the copper thus produced is, however, as a rule, low; and this because all the deoxidisers used have also the property of combining with copper, and the remarkable rate in which the conductivity of copper drops when small amounts of impurities are alloyed with it is well known. The amount of oxygen dissolved in copper during the process of melting is a variable quantity, and is distributed throughout the whole mass. It is, therefore, practically impossible to add the deoxidiser in such a way as to eliminate oxygen completely without, at the same time, alloying it to a certain degree with the copper. Accordingly, the conductivity of the resultant product is a matter of accident. In the laboratory sometimes good results are obtained, but they are hard to duplicate, and the transfer to the foundry is always a disastrous experiment.

What is needed for the solution of the problem is the finding of a deoxidiser which will have no affinity for copper (at least at the melting point of the latter) and which, therefore, can be added in excess with impunity. While carrying on the work of the isolation of the pure element boron, and its fusion, the lack of affinity of this element for copper manifested itself. Boron has, at the melting point of copper, a great affinity for oxygen and nitrogen. Pure boron can by this time be produced in large quantities, and is rather inexpensive for uses based on its electrical properties. For casting copper, however, its price would probably be too high.

In the course of the investigation mentioned, the writer prepared, however, an amorphous powder which contained as essential impurity only a certain percentage of oxygen, and which he terms "boron suboxide." The substance is prepared by a modification of the reduction process of boric anhydride by magnesium. Obviously, for the purpose of eliminating oxygen from copper without introducing any impurity capable of alloying with copper, this boron suboxide would be as good as pure boron, or perhaps better on account of its being obtained in form of a very fine powder. This substance was used in the first experiment. The very first attempt was successful. A perfectly sound bar was obtained with a conductivity of 94 per cent.; 0.1 per cent. of the weight of the copper was added. Further experiments showed that the amount of boron suboxide could be reduced to 1/30 per cent., and also that the addition of a large excess, say of 1 per cent., did not diminish the conductivity or change in any way the mechanical properties of the cast copper. Here was, therefore, a method which could be put into the hands of any foundryman, and which would always give good results provided the copper (ingots or scrap) melted down was pure metal.

A further simplification can, however, be introduced into the process. The reduction of boric anhydride of magnesium, the first being in excess, gives a product containing magnesium borate, boric anhydride, and boron suboxide. While the last one is the active agent, the first two are harmless. In fact, the presence of boric anhydride and magnesium borate is even an advantage, as the addition of a larger mass of material makes the operation easier; also the boric anhydride would probably dissolve the copper oxide and bring it to the surface as copper borate. It is therefore unnecessary to submit the direct product of the reaction to chemical treatment for the purpose of isolating the boron suboxide. It is sufficient to grind up the mixture into coarse grains and use an amount of it which contains the necessary amount of boron suboxide.

The foundry practice at present is to add 1 per cent. to 1½ per cent. of this material, which is equivalent to 0.08 per cent. to 0.1 per cent. of boron suboxide. The properties of the material obtained are as follows:—The electrical conductivity obtained can be as high as 97½ per cent. if the copper melted down is perfectly pure. In the foundry, where the scrap copper which is melted down cannot always be very carefully selected, a conductivity of 91 to 95 per cent. is obtained and a guarantee of 90 per cent. is given. The resultant casting is readily machined; fears which were entertained on this subject did not materialise and the engineers using the material have not complained on this account. The mechanical properties are as follows:—

Tensile Strength.	Elastic Limit.	Elongation. per cent.	Reduction in area per cent.
24,350	11,450	48.5	74.49

Castings are being made of all shapes and sizes with no more difficulty than in the case of brass. Sand and iron moulds can be used, and for standard articles the latter are preferred.

The use of cast copper lies in two different directions:—(1) Replacing forged copper. In this case a great saving in cost is often obtained. (2) Replacing alloys of copper. The gain in conductivity allows a reduction in bulk and thus a saving in material. The use of this material is spreading as the engineers get better acquainted with it, and is already of considerable magnitude. It is interesting to note that in spite of the fact that cast copper has lower conductivity than forged copper in many cases—as for instance, in case of current transformers—cast copper is being used

* From a Paper read before the "American Electro-Chemical Society."

† Research Laboratory of the General Electric Company.

now instead of forged copper. This is due to the fact that in casting a chance is given to eliminate riveted, screwed or soldered joints, whereby a number of poor contacts are avoided. Not only this, but the elimination of joints often insures a better operation.

The cost of the boron added is small; at the present prices of magnesium and boric anhydride the cost per lb. of copper is less than 0.375d. The success with "boronising" copper, as it is now called in the foundry, suggests new lines of work. Among these may be mentioned:—First, the addition of boron to different copper alloys; second, the replacing of the poling operation in the process of refining copper by a "boronising" operation.

Temporary Wooden Copes.

By Walter J. May.

In ordinary practice iron boxes are at hand for all the usual work which is carried on in the foundry, and certainly these should always be used where possible, but occasionally something crops up which, from its area, necessitates the making of a pattern and the casting of an iron cope, this being an expensive matter when only one or two articles have to be cast. An iron box part cast for such outside purposes probably would be useless for the ordinary work of the foundry, and when this part has to be stored away it usually proves a source of trouble and annoyance, owing to its size and inconvenience generally. Of course, if the job pays for it, the box-part can be broken up and re-melted, but generally the price obtained for castings will not warrant such an outlay.

In some places cast plates are made, and when carefully bolted together they answer well for outside sizes of boxes for floor moulding; but even in that case a lot of storage has to be provided, and unless there is a frequent call for their use they scarcely pay for the making and capital outlay.

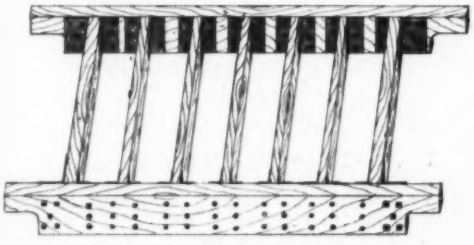

Fig. 1.

Wooden flasks and copes, although only of a makeshift character, often fill a temporary want, and they have the additional advantage of being easily and cheaply put together. Stout angle irons and bolts, and some tie rods are all that is necessary to keep the woodwork tight for one or two casts. The planks may be about 2 in. thick except where the boxes have to be very large, in which case the outer frame may very well be of 3-in. stuff, ordinary cheap white deals and planks usually being good enough for this kind of temporary work. All the wood should be rough sawn, and the rougher the surface of boards the better will the sand hold. In fact, it is as well to nail narrow fillets along both the sides and stays inside the boxes to assist in holding the sand in place when it is rammed up, and to wash the inside parts of the wood with good clay-wash so that the sand may be tightly held; for although there will probably be a little spring in the best-made box, yet this need not be such as to cause the sand to drop out if precautions be taken. Of course, the work being only of a temporary character, beyond having the boards squarely cut and of proper length, needless finish is avoided, and appearance goes for nothing.

To give a rough idea of the making of one of these temporary copes, Fig. 1 shows one to cover 6 ft. by . ft., the outer walls being of 3-in. by 9-in. white deal, and the stays of 2-in. plank. The position of the tie rods and angle plates are shown, and this indicates pretty fairly the method to be adopted as a general rule. Of course, in some cases the stays will have to be arranged differently to those shown, as all patterns are not flat, and at times the stays will need tie rods to strengthen them transversely, but this is not the general rule.

Fig. 2. Fig. 3.

In Fig. 2 the method of bolting the angles together is shown, the angle plates extending about 4 in. each way, except on the four corners of the main frame, where they should extend 6 in. and have five bolts instead of three. Quarter-inch cast, or one-eighth wrought plate should be used, and with ½-in. bolts these are enough, but the angle-plates should be the depth of the box-part. In Fig. 3 the method of fixing the tie rods is shown, and in Figs. 4 and 5 angle-plates and a sectional end of a tie rod are shown. As will be seen by referring to Fig. 5, two nuts and two plate washers are used, the plain rods being threaded down for a sufficient length to permit of this arrangement.

In Fig. 6 the method of placing fillets to help hold the sand is shown, this assisting considerably where the copes have to be set on edge for sleeking or other purposes. Trunnions are not, as a rule, wanted for this class of rough temporary work, lifting being done

Fig. 4. Fig. 5. Fig. 6.

from the handles left on the sides of the box; but, if preferred, there would be no difficulty in casting the trunnions with base plates to bolt on to the ends of the boxes. If they are used a tie rod should run the length of the box both above and below the trunnions.

Taken as a whole, wooden boxes are useful for temporary purposes in the foundry, but except in places where metal is scarce—as in new countries, for instance—they would not be used for general work, although wooden foundry boxes were at one time pretty largely used.

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Machine-Moulded Spur Gears.

By Arthur Greenhalgh.

The methods adopted in this class of work vary according to dimensions and types. Generally, a bed and a top are swept up by means of striking boards. Two, three or more teeth are used on the moulding block, the arms are formed by means of cores, shroudings are swept up, and boss facings

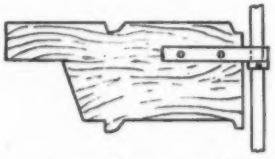


FIG. 1.—BOARD FOR MOULD NOT TURNED OVER.

deeper than the wheel face are either swept up or bedded in. The moulds are made either in green or dry sand.

The methods of making spur gears may be broadly divided under two heads. In one the top is rammed on a dummy mould; in the other it is swept up and turned over.

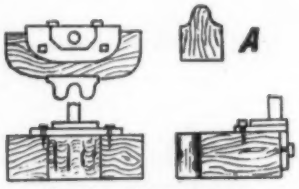


FIG. 2.—TOOTH STOCK.

Moulds Not Turned Over.

These usually include those of large dimensions, say of from 4 to 6 ft. in diameter, which are moulded in the floor sand. The reason for not turning over is that of size and weight. In the case of these, a dummy mould is first rammed and strickled or swept up. If the top is plain, a plain sweeping board

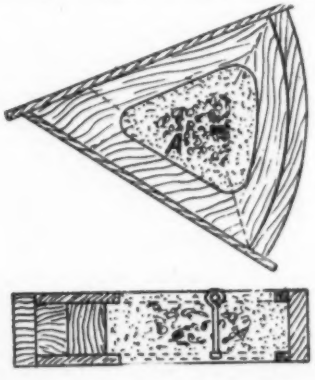


FIG. 3.—CORE RAMMED IN BOX.

attached to the central bar of the machine will strike it. But an absolutely plain top is not often employed. If there is a central boss, it can be cut in the board, or its pattern can be centred on the top and rammed over. A friction collar would be swept by the striking board, the top edge of Fig. 1. The top is then centred and set by stakes, and liftered or gaggered, rammed and then lifted off.

Then the sand in the bed is dug out, and the bottom strickled with a board having its edge cut suitably for boss, or friction collar, the bottom edge of Fig. 1, and for making a sloping wall of sand an inch or two outside the teeth, as a perpendicular wall would

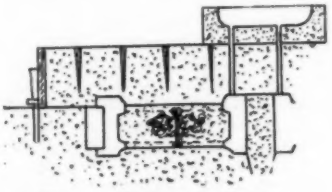


FIG. 4.—FINISHED MOULD.

tumble down. In sweeping up the bed, which is a permanent part of the mould, care must be taken to ram and consolidate it well, and to vent those areas of it which are to form casting faces, all those which will not be actually covered by the arm cores.

The ramming of teeth follows. This is done by a tooth block, Fig. 2 attached to the machine carrier, and pitched and rammed in succession. The depth of the block and its radius, and the tooth sections

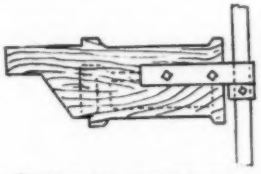


FIG. 5.—BOARD FOR TURNED-OVER MOULD.

alone are important, because the cores form the interior of the rim. The tooth spaces form the tooth moulds. Two teeth only were formerly used, so that one tooth only was rammed at one pitching, but three, or four teeth are more economical of time. The space between the sloping faces of the teeth is rammed, nailing and venting being done in detail as the moulding proceeds, and the sand kept from lifting during withdrawal by the piece A, Fig. 2. Cores are

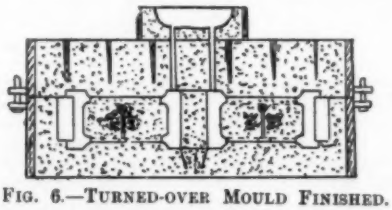


FIG. 6.—TURNED-OVER MOULD FINISHED.

rammed in a box, Fig. 3, the making of which is simplified by fitting the framed sides to the exact angle which corresponds with the number of arms in the wheel, say 6 or 8. Then the arms and boss are fitted within the frame, all loosely for convenience of withdrawal from the core after ramming. Instead

of making a wooden frame for every distinct wheel, a few standard frames are kept, and the loose fittings for many cores of different sizes are placed within these. A better method is to keep a standard iron frame, and use this for the same purpose. The cores are rammed on a grid, with an eye or eyes for lifting by, Fig. 3. A central body of cinders or coke is rammed in the space A to receive the vents from the outer portions of the core. The air escapes through a hole in the top of the core, and away through the top box. Properly, the cores should be in dry sand. They are laid in the bottom of the mould by measurement, provided by gauge strips representing the thick-

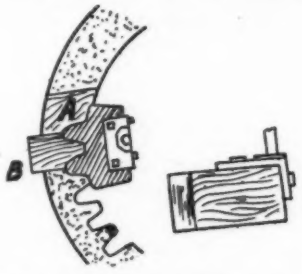


FIG. 7.—RAMMING OF TEETH.

nesses of the arms and rim. The mould is poured through the central boss only, as shown in Fig. 4, except in the case of large wheels, when runners are also brought into the rim.

Turned-Over Moulds.

These are adopted in wheels moulded on the tables of machines. The top part is swept distinct from the bottom, and the two only come together at the closing of the mould. Accurate register of the two is ensured, not usually by an annular check projecting and recessed to match, as in loam moulds, but simply by registering, or setting of the moulding boxes in relation to the central striking bar. It is usual to cut the striking edges for both parts of the mould on opposite edges of the same board, as in Fig. 5, rather than on separate boards, as these may become separated or misplaced in the stores.

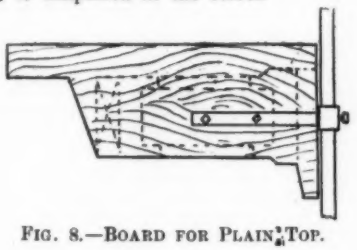
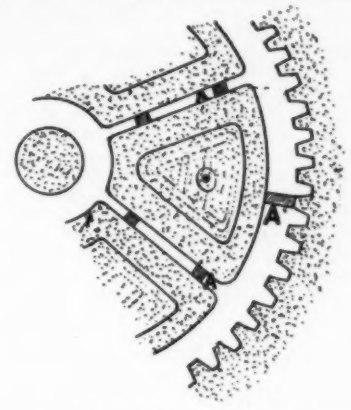


FIG. 8.—BOARD FOR PLAIN TOP.

A half section of the wheel is generally drawn on the board to assist the moulder, and two gauge strips are provided. One strip is a guide to set the strap by, so that the joint edge shall be on the joint of the box. The other strip gives the diameter of the teeth at the points. Each box is set concentrically with the central striking bar, and as the top and bottom moulds are rammed and swept thus, they are bound to be coincident when brought together. Fig. 6 shows the vertical section through a turned-over mould when closed, Fig. 7 shows the ramming of teeth; the tooth block has been moved away from a portion of the finished mould, a tooth space has just been rammed, and the piece B, shown at A in Fig. 2 is in place, ready for the lifting of the block. The block A next to the farther outside of the teeth is laid there to support the sand on that side and prevent it from falling down. Fig. 8 represents a board cut for a plain top, suitable either for a bedded in or a turned-over mould. The section of the wheel is drawn on the board. The core-box,



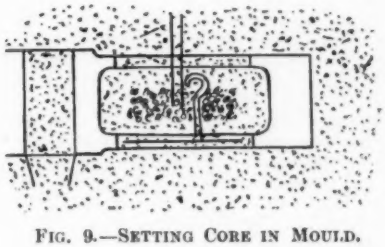


FIG. 9.—SETTING CORE IN MOULD.

Fig. 3, is drawn for this wheel. In Fig. 9 the method of setting the cores with thickness pieces A, A, is shown, as is also the central vent hole from the cinders. Fig. 10 shows the method of moulding a ring of teeth with a large boss and short arms. The central core being large, is made up of segmental lengths. Thicknesses are set by strips as in Fig. 9.

The foregoing remarks apply to the main elements

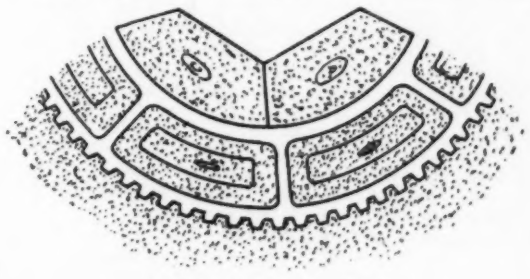


FIG. 10—RING OF TEETH.

only in the work of spur wheel moulding. Much detail and many variations have not been touched upon. The principal differences relate not to the moulding of the teeth, but to the shapes of the arm sections, and the attachments which may be cast with the wheels. Most gears are made with the arms of H section, and these are more readily made in cores than are those of other shapes. Some wheels have no arms, but plate centres instead, and these may be swept up with boards, or made in annular cores. Gears may be cast together, or brake rings to gears. In all such cases that arise the judgment of the pattern-maker and the moulder has to be exercised.

Some Recent Tests of Cast Iron.*

By Alexander E. Outerbridge, Junr.

In the Proceedings of the American Society for Testing Materials, 1903, Vol. III., p. 216, will be found a Paper by the writer in which attention was called to the extraordinary variation in the physical properties, such as strength, hardness, softness, ductility, density, size of grain or "fracture," etc., of test bars or other castings of different thicknesses, poured from one ladle of molten iron, due to differences in the rate of cooling of the metal. No comparable variations, caused in this way, exist with other metals, such as the non-ferrous alloys, or even with steel (except in a minor degree); and it is no exaggeration to say that the rate of cooling of grey cast iron exerts as important an influence in determining its physical properties as does variation of its chemical constituents, within, of course, certain wide limits.

In the Paper referred to, four hypothetical cases were cited in illustration of this dictum, and several actual tests were recorded. Some of these records were of experiments made by the writer over 20 years ago, while others were of more modern date. Some of them showed the difference in fracture, strength, density, etc., between sections cut from the centre and those cut from near the surface of comparatively large masses of metal. Others showed remarkable differences in tensile strength between round bars of different diameters in the rough, cast from one ladle, and turned to different dimensions. The following conclusions were drawn from these tests :—

> The rate of cooling of cast iron from the fluid to the solid state is such an important factor in determining the physical properties of the metal, that it is just as necessary to know the dimensions of the test bars as it is to know the chemical composition. For the same reason, it is equally desirable that standard sizes of test bars should be adopted, which would be suitable for different grades of iron.

Since that time some progress has been made in this country toward the standardisation of cast-iron test bars, largely through the efforts of Dr. Moldenke and a Committee of the American Society for Testing Materials, but there is still a lack of uniformity in the practice prevailing in this country and in Europe, which it is hoped may eventually be rectified.

Very recently the writer has had occasion to again observe the operation of the law of rate of cooling of cast iron in test bars varying but slightly in dimensions. In these later experiments the bars were accurately turned to uniform size and pulled on the 100,000-lb. hydraulic testing machine of William Sellers & Company, Inc. It happened that a number of experimental castings were required, which would show very much higher tensile and transverse strength (the former to range from about 27,000 to 40,000 lbs. per square inch) than if cast from ordinary foundry iron, and at the same time should be absolutely free from brittleness or hard spots in any part of the castings, which were only about $\frac{3}{8}$ in. thick in the thinnest portions.

Experimental Results.

Two test bars, 1 by 1 by 15 in. and $\frac{3}{4}$ by $\frac{3}{4}$ by 15 in., were poured from the same ladle as each casting. The object of making two sizes of test bars varying only $\frac{1}{4}$ in. in lateral dimensions, was to approximate as closely as possible the cooling conditions existing in the castings, which varied in thickness. The larger bars were broken transversely in a testing machine, using a span of 12 in. Then one of the broken pieces from each transverse test and each of the smaller bars were turned to a diameter of 0.505 in. between threaded ends and pulled in the 100,000-lb. testing machine. The smaller bars were not subjected to the transverse test. Only tensile tests are recorded herein, and all represent tests of different bars, not duplicate tests of any single bar.

The ratio between the transverse strength of a bar 1 in. square, not machined, tested on a 12-in. span, and the tensile strength of the same bar machined, is about 1 to 10 with ordinary foundry iron, about 1 to 11 with stronger iron, and about 1 to 12 with very strong iron.

The following interesting points may be noted :—

1. The uniformity of tensile strength of different bars of the same dimensions cast from one ladle of iron.

2. Invariably the smaller test bars ($\frac{3}{4}$ in. square) of any series, if free from flaws, show higher tensile strength than the larger bars (1 in. square) cast from the same ladles, thus fully corroborating the observations previously recorded in 1903.

3. In machining the test bars, it was observed that the chips from the bars of the stronger metals (both from those 1 in. square and those $\frac{3}{4}$ in. square), instead of breaking off short, like ordinary cast iron, were quite curly like soft steel or wrought-iron turnings.

4. In all cases save one, the metal of the castings in the thinnest section ($\frac{3}{8}$ in.) was entirely free from chill, or mottled iron, and was readily machineable. In the exceptional instance the metal was perfectly grey in the test bars and in the castings themselves, except in the thinnest portions where it was almost white, due to the more rapid cooling of these very thin walls.

A study of the tests showed that the minimum increase in the average tensile strength of the two test bars $\frac{3}{4}$ in. square, over the average tensile strength of the two bars 1 in. square, cast from the same ladle and turned to the same diameter, was 2,250 lbs. per square inch. The maximum increase under like conditions was 7,500 lbs. per square inch.

It is certainly remarkable that differences so large should occur between bars differing so little in dimensions, cast from one ladle and presumably of uniform mixture of iron. It shows how very sensitive the metal is to cooling influences, and again reveals the importance of adopting standard sizes of bars for tests of cast iron.

* Read before the American Society for Testing Material June, 1910.

THE "INCANTO" OXY-ACETYLENE WELDING SYSTEM.—In our last issue we published particulars of the "Incanto" oxy-acetylene welding system. The sole manufacturers and patentees of the generators, purifiers and other apparatus therein referred to, we may state, are Messrs. Thorn and Hoddle Acetylene Company, Limited, acetylene engineers, 151, Victoria Street, Westminster, S.W.

Pattern-Shop Preparations for Moulding Large Base-Plates or Entablatures.

By "T.V.D."

In the FOUNDRY TRADE JOURNAL for July, 1910, there was illustrated a cast-steel base-plate for a 4,500 ton hydraulic forging press. The weight of this base-plate was 56½ tons, and the over-all dimensions as follows:—Length, 16 ft. 3 in.; width, 8 ft. 1 in.; depth, 6 ft. In the present article it is proposed to describe the work of the pattern-maker in preparing for the production of such a casting.

The making of a pattern in the ordinary way for so heavy a casting would be expensive both as to time and material; and the pattern would, also, be of such a weight in itself, that the moving and handling of it would be a difficult matter for most pattern-shops. Such castings are therefore, moulded in the Sheffield foundries, by the method of cope-cores (or in shop vernacular "copes") and cores only. Fig. 1 shows the design of this base-plate to be regular and symmetrical. The four corners are equal in size and shape, and the four projections on the sides are also exactly alike. It is an easy and cheap method, both in the pattern-shop and foundry, to prepare the mould by the use of cope and core boxes. The pit for this mould is prepared in the ordinary way, except that it is somewhat wider and longer than if a full pattern were to be used. For the casting shown, four feet wider and five feet longer than the overall dimensions of the casting are sufficient, as the working thicknesses of copes are arranged to be not less than one foot in the smallest part.

The outside formation of the mould is the first to be considered. A full-size section of one quarter of the plan of the base-plate is set out as at S, Fig. 1. This is also shown in Fig. 2. Twelve inches are marked off by lines A, B, and A, C, Fig 2, as the working thickness of copes mentioned above. On account of the castings being steel, all measurements, pattern-shop and foundry, are to the steel contraction rule. It is necessary to bear in mind that all cope and core-boxes prepared for these large castings are made one thirty-second to one-sixteenth of an inch per foot less than the steel-contraction rule sizes; this allows for expansion of the copes and cores in drying.

The cope-box A is made as shown in Fig. 3, the breadth and width agreeing with lines A, B, and A, C in Fig. 2, the depth 7 ft. less allowance for expansion. Two copes are made out of this box for corners marked A and A¹ on plan of mould, Fig. 7. By turning this box upside down, the copes will be right-hand for the remaining corners A², A³.

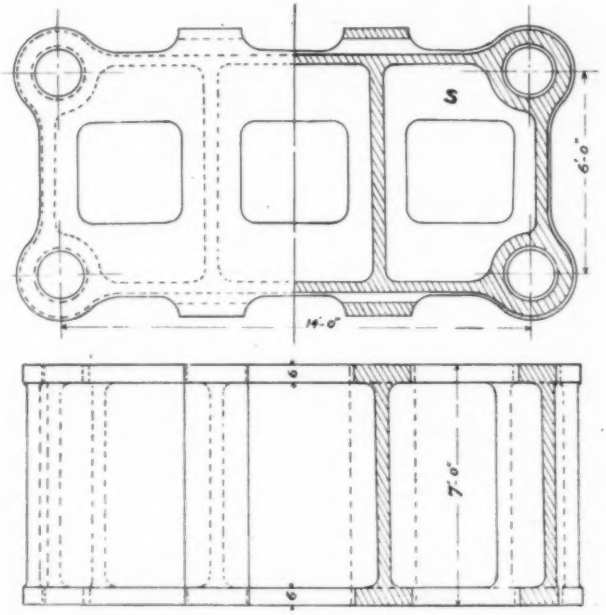


FIG. 1.

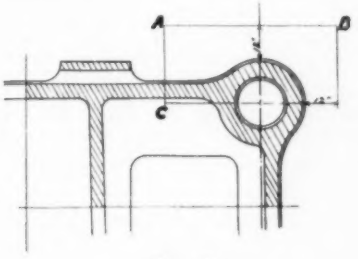


FIG. 2.

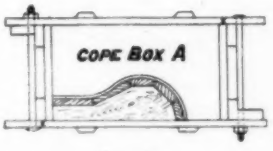


FIG. 3.

It will be noticed in Fig. 3 showing cope box A, that arrangements are made to facilitate the releasing of the box from the cope when rammed up. The two corners marked X, are securely and permanently fastened. The opposite corners are made to butt up to the sides. The whole is firmly held together by long bolts and nuts passing through from side to side at each end. When the nuts are taken off, and the bolts pushed back, the box will part from the cope at opposite corners, leaving it standing upright as it will stand when placed on the floor of the pit, in the position marked out for it. This is the easiest position for the moulder to examine it, and to enable him to make good what is required and prepare it for drying. The boxes should be strong and firm,

to ensure the copes and cores being square and true, and to ensure that the process of ramming does not cause the boxes to bulge.

The same proceedure is adopted with box B, Fig. 4,

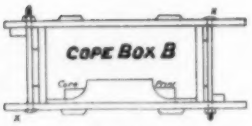


FIG. 4.

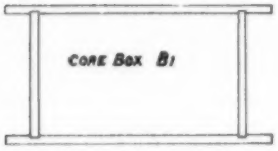


FIG. 5.

except that four cope-cores are made out of it, these being all of one hand. Fig. 4 shows two core prints placed on the projection therein. These are the seats to receive the core out of the core-box B^1, Fig. 5, which will be fastened on these seats before being dried. The combined cope and core become one, which is placed in position as such. Cope-box C, Fig. 6, is the last for the formation of the outside of the casting. Two copes are made out of this box, one for each end.

FIG. 6.

The moulder's work will not be dealt with here, except so far as it is in direct conjunction with the pattern-maker. Assuming therefore that the pit is quite ready for the reception of the copes for the outside of mould, the pattern-maker will set out the required centre and cope lines on the floor of the pit, to which the copes are set. These lines are shown in Fig. 7, also the copes placed in position on one side and the two ends. The four round cores F, Fig. 7, are struck up on barrels (which are taken out

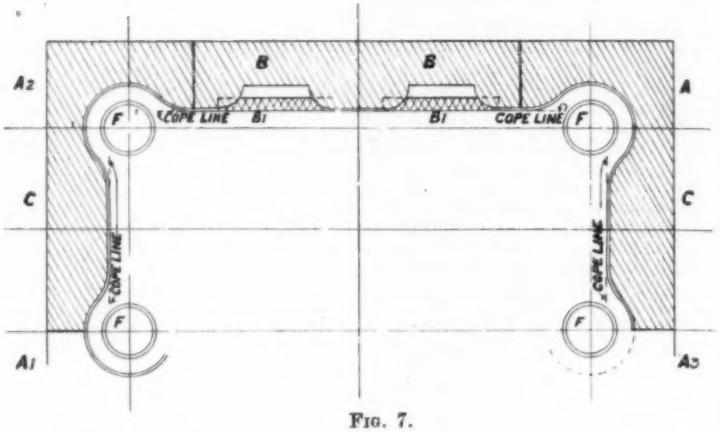


FIG. 7.

after drying); special care being taken to have the ends upon which they stand square and true. Fig. 8 shows the coreboard for striking up these cores, the projection marked **X**, hollowing out the end upon which the core stands and prevents it wobbling. No core-prints are required for guiding these cores into position, but they are fixed or set to the circles marked F, Fig. 7, and their vertical truth checked.

After the whole of the outside copes and the four

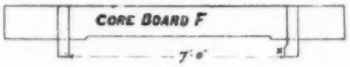


FIG. 8.

round cores marked F are in position, the inside cores are dealt with, the end ones being first fixed. Fig. 9 shows the box for cores D and D^1, Fig. 10. The centre core D^1 is made out of the same box when the pieces marked **X** are removed. Fig. 10 shows the whole of the copes and cores in position. The various thick-

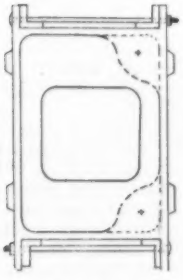


FIG. 10.

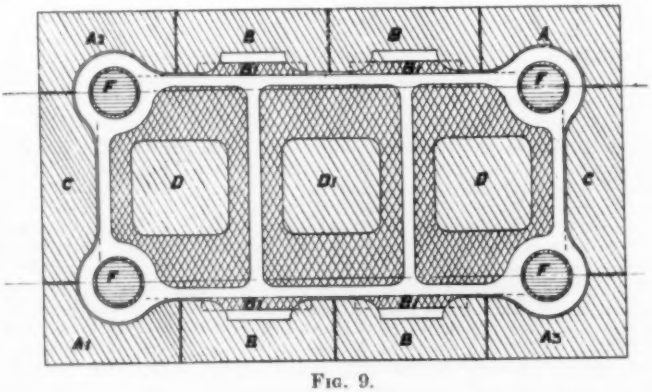


FIG. 9.

nesses or spaces between them having been tried, usually with wood gauge pieces that will reach to the bottom, and found correct, the mould is ready for top part, a plain level surface to cover all in.

Roots' Blowers.*

Apparatus for foundry practice to be used for blowing cupolas, etc., may be divided into two classes, the first being the centrifugal machine or deprimogen, which means a machine which raises a pressure on the one side by creating a vacuum on the other. The pressure of the blast produced by such a machine varies essentially with the speed of the periphery of the disc, and so, supposing an 84-in. fan when running at 675 r.p.m. delivers 12,000 cubic feet of air at 14 in. W.G., the W.G. will be reduced to 7 in. when the speed is reduced to 480 r.p.m., and the output or cubic feet reduced proportionally, or say 8,500 cubic feet. Under these conditions, it will be seen that in order that a fan shall be suitable for a cupola in which the resistance offered by the charge of material to be melted (iron and coke) approximates to say 21 in. W.G., a considerable excess of speed must be allowed for in case of the cupola offering greater resistance than that anticipated. At such gauges the fan labours under the difficulty of the obligation to run at varying and very high peripheral velocities, and also the mechanical efficiency is very low, the water gauge being considerably above the economical capacity of a single-stage machine of the centrifugal type.

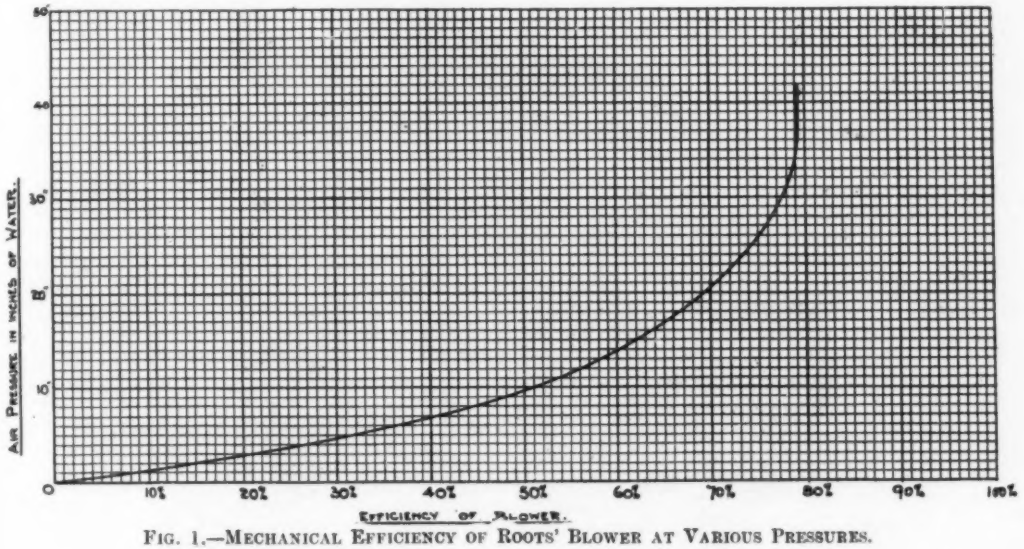


FIG. 1.—MECHANICAL EFFICIENCY OF ROOTS' BLOWER AT VARIOUS PRESSURES.

The Roots' blower, as compared with a centrifugal fan, belongs to the type of volumogen machines, where the volume is dependent on the frequent filling and emptying of a cylinder, by means of pistons in the case of a reciprocating blowing engine, and by means of revolving members, more or less taking the form of rudimentary cog wheels gearing into each other, as in the case of a Roots' blower.

Although it figured early in the last century, as shown in Bourne's book on the screw propeller (1852), the actual blower as now known was brought to England by the firm of P. F. & H. M. Roots, of Philadelphia, and exhibited at the 1863 exhibition in London, and the patent rights in this country were acquired by the firm of Thwaites & Carbutt, of Bradford. Naturally modifications in detail and construction, improvements in manufacture and accuracy of workmanship have been introduced since 1864.

All blowers now made by first-class firms are fitted with cast-iron revolvers machined all over and at the ends. The casings in which they revolve are bored to such a degree of accuracy that the slip at high pressures is reduced as far as possible; the gearing which synchronises the running of the revolvers is of cast iron, or, in some cases, of steel, and the teeth are machine-cut, and run in an oil box. The form of bearing for the shafts differs amongst different makers and according to specification, being either of the conical adjustable form, lubricated by Stauffer or other oil cup, or parallel bearings lubricated by oil, or parallel bearings with ring lubrication. The method of driving may be by belt at one or both ends, by motor through reducing gear, or by engine, either of the duplex crank type, where each revolver shaft is connected to a crank disc driven by connecting rods from a crosshead common to the two rods, or by engine, either single- or double-crank, driving one shaft of the blower only. This form is more generally used for the larger sizes where the speed is comparatively slow, and the engines may be compounded for use with high-pressure steam. The firm with which the authors are associated have recently introduced a method of driving by a high-speed engine, enclosed, and fitted with force lubrication. Owing to the higher speed at which these engines can be run, it is possible to employ a smaller blower than would be the case when they are driven by an open-running engine, and considering the difficult and dusty conditions under which engines and blowers have often to work, the protection afforded to all running parts of an engine by the enclosed type of construction is of great advantage.

Volumetric and Mechanical Efficiencies of Blowers.

Blowers are usually rated in catalogues in numbers or letters, as No. 1, 2, 3, etc., or alphabetically as

* Abstract of Paper read before the Birmingham Branch of the British Foundrymen's Association by Arthur D. Ellis, A.R.S.M., and Charles E. Johnson, of Thwaites, Bros., Ltd., Bradford.

A. B, C, etc., and described as capable of delivering so many cubic feet per minute when running at a number of revolutions stated in the catalogue. Occasionally, commercial difficulties arise over such a description, as such description refers to volume swept by the revolvers against no resistance, or, in other words, free air drawn in at the suction and delivered at the outlet. It is well-known to foundrymen that the volume of air decreases proportionately with the pressure, and consequently not only is the volume delivered less than the volume described in the catalogue, but as the pressure increases the slip or air which does not pass through the revolvers is proportionately greater. This amount of slip can be reduced by very careful machining, but the expansion of the revolvers at the temperature produced by high compression of the air, causes them to bind in the end-plates, and clearance must be allowed for this, since it would be difficult to maintain this constantly without the use of packing strips, which would increase the friction of the machine enormously, and which as a mechanical problem are very difficult to fit. Blower makers, therefore, prefer to make a fair allowance for slip, and at some reduction in the volumetric efficiency, and run the blower at a speed sufficiently high to compensate for this slip. At low pressure of 16 in. to 28 in. of water, the blower is probably at its highest volumetric and mechanical efficiency, but this again will vary with the size of blower and volume of air to be delivered, as the frictional resistance of a smaller blower is proportionately greater than that of a large one. It is consequently to be preferred that for exceptional cases the purchaser should state his exact requirements, viz.:—(1) The volume of free air to be delivered against the resistance required; or (2) the volume of air when compressed to a stated pressure; or (3) as is sometimes the case, state the size of orifices through which a stated volume of air is to be passed, and this will then determine the eventual pressure of the blast. The constructor will then be in a position to determine the amount of free air it will be necessary to pass into the blower, the amount of loss he should allow for slip in the revolvers, and the horse-power

FIG. 2.—NO. 10 BLOWER AND COMPOUND DUPLEX ENGINE.

required, not only for the volume at the stated pressure, but for that lost by slip, and thus determine not only the volumetric, but also the mechanical efficiency of the blower under consideration.

For the employment of blowers for cupolas in iron foundries, the normal pressure determined by the resistance offered by the material in the cupola varies between 21 and 28 in., and the volume of air required is between 650 and 700 ft. of air per minute per ton of iron charged per hour, and this will require about 2¼ to 3 b.h.p., according to the length of the blow, which may be taken as the normal power required per ton of metal melted per hour, allowing for a small decrease with an increased capacity of cupola.

For larger cupolas above 4 ft. diameter inside the brickwork, it is sometimes desirable to increase the pressure offered by resistance of the charge by a small restriction of the diameter of the tuyeres, so that the pressure may be as much as 1½ or 2 lbs., and obtain better penetration of the blast to the interior of the cupola.

For special purposes, such as providing blast for side-blown converters and other industries where these moderately high pressures are required, the blower remains a fairly efficient machine to pressures of 5 or 6 lbs., and, if the price of the machine is taken into consideration, the high-pressure blower will compare favourably with the more highly mechanically efficient reciprocating blowing engine.

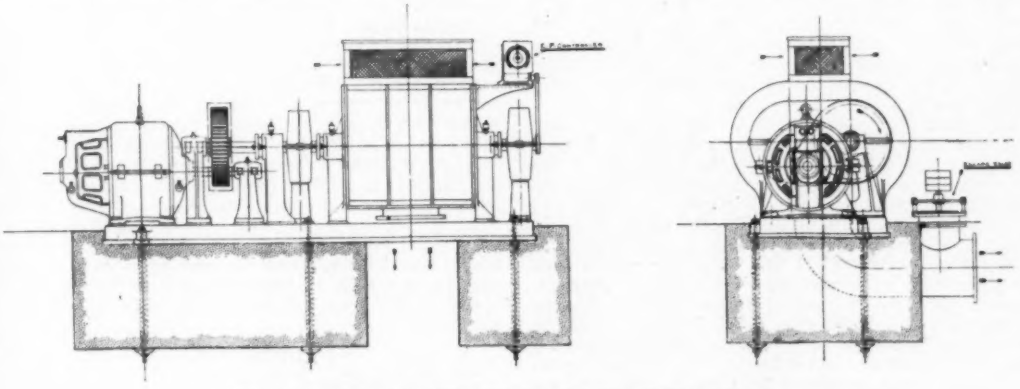


FIG. 3.—THWAITES' ELECTRICALLY-DRIVEN ROOTS' BLOWER.

Appendix.

The authors have thought that certain formulæ may be of use to members of the Association, and, therefore, add those for determining the horse-power of any volume of air at given pressure, and also that for determining the volume of air when compressed to certain degrees.

Formula for obtaining the brake-horse-power required to drive blowers.

$$\frac{C \times W}{4{,}400}$$

C = cubic feet of free air per minute.
W = pressure of air in inches of water.

Decrease in volume due to compression =

$$\frac{C \times 15}{P \times 15}$$

C = cubic feet at atmospheric pressure; P = lbs. pressure per square inch.

[The paper included a diagram showing the curve of efficiency of blowers at certain water gauges, and diagrams of steam engines and efficiency of blowers by comparing horse-power in air to horse-power in the steam. Some of these are reproduced herewith.]

The Osborn Spark Arrester for Cupolas.

In our issue of May last, we published a description of the Osborn spark arrester for cupolas, which is the joint invention of Messrs. Samuel Osborn and D. Carnegie. This apparatus, we understand, has been successfully adapted by Messrs. Hornsby at their foundry at Reddish, near Stockport, to a pair of cupolas which were formerly fitted with drum-type arresters, and has been applied to a single cupola at the foundry of Messrs. Stubbs, Manchester. The arrangement for one cupola, it will be remembered, consists in fitting to the top of the cupola a firebrick-lined flue which is bent over in the form of an arch. At the top of the arch is provided an opening for the escape of the gases, and on the side of this opening nearest the cupola is provided a durable firebrick baffle of a depth sufficient to intercept and deflect the sparks. In the case of a single cupola the flying particles are taken forward and down a continuation of the flue into a chute or receptacle placed to receive them. In the case of a pair of cupolas, one of which is used at a time, the place of the chute is taken by the second cupola, a second baffle plate being provided on the other side of the gas outlet. At Messrs. Hornsby's works the output of the cupolas is about 120 tons of metal per week; the cupolas are 5-ft. diameter and the flues 34-in. inside diameter. The baffle in this case is 1 ft 4 in. deep, and the working pressure 26-in. water gauge, or slightly less than 1 lb. At Messrs. Stubbs' works the output of the cupola is somewhat greater, but the working pressure is only 11 in. of water, or considerably less than ½ lb. per square inch. The cupolas and flues are the same size, and Messrs. Stubbs find that a baffle 4½ in. deep gives the best result as regards output of the cupola, although it is not quite so effective in preventing the escape of the finer dust as the deeper baffle. The amount of sparks collected in both cases shows that the appliance is very efficient. The material arrested amounts roughly to about 1 ton per 100 tons of metal melted, and consists of fine dust and small cinders which would otherwise find their way under the slates of the roofs and into the gutters, causing damage. Messrs. T. Davies & Son, West Gorton, Manchester, are licensees and makers of the apparatus.

Copper-hardened Aluminium.

With Some Notes on Duralumin, by A. Napier.

Aluminium being a comparatively new metal in the metallurgical world, it has not gone through all the phases of experiment and practice of alloying which many of the other non-ferrous metals have witnessed; and even to-day, despite that special researches have been instituted to determine the effects of various elements in producing aluminium alloys, the field of possibilities before the metal has only been fringed. The alloys consisting chiefly of aluminium are the ones to which attention has been mainly directed, for one of the most important and useful features of the metal—its lightness as compared with copper and most of the other non-ferrous metals—is lost if large quantities of heavier metals are added. As stated in text-books, too, aluminium unites with most of the common metals to form definite chemical compounds which crystallise out in a matrix of practically pure aluminium, and the character of these alloys does not recommend them for the general run of purposes to which aluminium is applied. This means that the metals which can be employed in the alloy are usually limited to a few which form solid solutions with aluminium, these including zinc, manganese and magnesium. Exception must be made, however, in the cases of copper and nickel, both of which metals have been employed as hardening agents, though they belong to the first-class mentioned.

As regards the use of nickel, this metal has been employed as a hardening agent, and as such is very effective; but at the same time the toughness of the aluminium is somewhat sacrificed, the alloy being more brittle. One American alloy hardened by nickel was made by adding nickel oxide directly to the bath in which the alumina was electrolised, and a tensile strength in castings of 11 to 13 tons per square inch was claimed. The analysis of the alloy, however, showed small percentages of other metals, including copper, iron, silicon and zinc, and it is quite reasonable to consider that the results obtained did not represent only the effects of nickel hardening. Nickel-copper-aluminium alloys have also been made, and good results claimed for them, but at the present time nickel does not appear to be used to any considerable extent as a hardening element in the aluminium alloys.

Unlike nickel, copper appears to be increasing in favour for hardening the alloys in question, and is employed up to 10 per cent. These alloys have been the subject of extended experiments by the Alloys Research Committee, and tensile test on sand castings showed that only those containing 6 per cent. or less of copper were of real industrial value. When 4 per cent. of copper is reached a decrease in ductility commences as the copper content increases, while the tenacity does not correspondingly increase. At one time zinc was considered the most suitable metal to use with aluminium, and it is still largely employed, but the various troubles and difficulties which the foundryman encountered when using the zinc, turned attention to copper as being, for many purposes, the more suitable hardening element—particularly as a comparatively large amount of zinc is required to give a hard alloy. As a result, a number of alloys containing from 3 to 5 per cent. of copper are now employed in the motor car industry, and for other purposes where strength and lightness are desired.

Manganese as an addition to aluminium has been employed in amounts up to 2 or 3 per cent., and in such quantities exists in solid solution, and increases the tensile strength of the alloy. But it is in conjunction with copper that manganese has received most attention. Experiments with these alloys have been carried out by the Alloys Research Committee, and it is not necessary to deal with the subject at the present, as the results have already been published in full. But it may not be out of place to recall some of the results obtained. One alloy containing 2.15 per cent. of copper and 1.91 per cent. manganese showed as sand castings on the tensile tests a yield-point of 6.68 tons per square inch, ultimate stress 8.10 tons per square inch, and elongation 5 per cent., while as chill castings the results showed yield-point 7.80 tons, ultimate stress 10 tons, and elongation 5 per cent. It was noticeable, however, that these alloys showed no marked superiority over the corresponding series of copper-aluminium alloys. But it was clearly indicated during the experiments that the alloys are very sensitive to the method of casting adopted and to variations in the casting temperature.

Magnesium has also figured prominently as a component metal in the aluminium alloys, and under such trade names as "Magnalium," several of these have been put on the market. Usually under 2 per cent. of magnesium is present, and while up to 10 per cent. has been suggested as giving good results for sand casting, the cost of such an alloy would be prohibitive for ordinary purposes. Most of the alloys in which magnesium appears contain also small percentages of other metals, as copper, nickel and tin, while silicon is also contained in some. Silicon, it may be mentioned, has a hardening effect on aluminium, and is occasionally introduced for that purpose. For casting purposes 5 per cent. is stated to have no bad effect, but more than 2 per cent, renders it less malleable. Silicon, however, may sometimes be present as an accidental impurity, as it can be taken up if the metal is melted in contact with any siliceous material.

Duralumin.

The consideration of the various hardening elements that have been employed with aluminium, brings us to the subject of an alloy which has recently created a great deal of interest in metallurgical circles. This alloy is called "Duralumin," and its principal features are its exceptional lightness, the specific gravity being about 2.80, and its high tensile strength and elongation. The alloy is in its essential composition aluminium hardened with copper, the former metal running to over 90 per cent., and the copper about 4 per cent. This alloy is said to be suitable for drawing, stamping, extruding, and forging at a suitable temperature. As already indicated, copper-hardened aluminium alloys have been extensively used, and are familiar to most metal workers as being suitable for rolling, etc.; but the feature of Duralumin is that its physical properties place it on a plain with mild steel. The experiments of the Alloys Research Committee with aluminium-copper alloys of about the same copper contents as Duralumin did not give test results approaching those quoted for that metal, the highest of which were as follows, the sample being cold-rolled sheet:—Tensile strength, over 39 tons per square inch; elastic limit, 38 tons; elongation, 3.5 per cent.; reduction of area, 10 per cent.

To those familiar with the results obtained from the Al—Cu. alloys, the qualities of Duralumin may suggest a composition of a very special nature in order to give the results obtained, and certainly an

alloy of this character that will compete with mild steel is rather extraordinary. Of course, in considering the qualities and properties of such special alloys as compared with ordinary sand-cast alloys, it is very necessary to give regard to the effects of heat treatment and mechanical treatment. Duralumin is quoted as giving high results, but only as a worked metal, and not as a cast alloy; in fact, it is apparently not recommended for casting purposes, and this fact leads to several assumptions, which will be dealt with later.

In the reports and references concerning Duralumin that have been published recently the alloy is discussed rather as an expensive substitute for mild steel, to be employed for special purposes where lightness is an essential feature. To that extent it does not greatly concern the foundryman; and while other of the copper-hardened aluminium alloys have in the past been well favoured for rolling, some have also offered great posibilities for the foundryman. It may be interesting then, to examine the nature of the new alloy, and inquire by what means the high test results are obtained. According to one analysis that has been published, the chief constituents are, as already stated, aluminium and copper, with small quantities of iron magnesium and silicon, the analysis in question being Al. 94.60 per cent., Cu. 3.90 per cent., Fe 0.45 per cent., Mg. 0.75 per cent., Si. 0.21 per cent., with also a trace of manganese. The presence of the iron probably results from that metal being in the original aluminium used in the mixture; but it is significant that among the other minor constituents are those which are commonly employed as deoxidisers in non-ferrous foundry work, and this leads to the assumption that great care has been taken to thoroughly deoxidise the alloy.

Leaving for a moment the question of heat treatment and the effects of mechanical treatment, it is well to give due consideration to the possibilities of alloys that are thoroughly deoxidised. In experimenting with non-ferrous metals endeavour should naturally be made to use only comparatively pure metals, but that does not ensure the finished castings being absolutely clean unless there are employed some elements for eliminating the oxides which inevitably occur in melting and pouring; and these are not in all cases included among the constituents of the mixture with which it is desired to experiment. It will not be news to any aluminium founder to state that the metal is a rather ticklish one with which to get clean, sound castings. The melting point, in the first place, is very low—much lower than that of the copper used to harden it—and there is consequently a danger of over-heating, which would result in the metal oxidising unduly, and when this occurs it is difficult to get a casting free from blow-holes and weak spots. Practice varies a great deal as regards the melting and pouring of aluminium alloys, particularly as regards the protective means employed and the addition of substances to the crucible to clean the metal; but it is agreed among founders that it is essential to avoid over-heating the metal. The great difficulty with the metal during melting is the tendency to form dross on the surface, and even though this be skimmed off before pouring, that does not ensure clean metal. The oxides are very little lighter than the metal itself, and the two tend to form a thick pasty mass, instead of the oxides rising to the surface; and if the metal put into the pot is not fairly free from oxides the trouble is doubly present.

In discussing the possibilities of the aluminium alloys, then, one must not be guided too much by past experience in ordinary foundry practice; for what may give excellent results under properly regulated conditions may fail utterly to come up to requirements as the result of some seemingly trifling feature. For a concern which is handling practically pure metal under comparatively ideal conditions, results are possible with alloys that would fail in the hands of a less experienced founder, and under less perfect conditions. This may offer something of a solution to the excellent results obtained from Duralumin, and it may reasonably be concluded that the qualities of that alloy depend largely upon the use of pure metals, melted and poured under the best possible conditions and thoroughly deoxidised by the judicious use of elements other than those employed for the actual hardening. The sensitiveness of the aluminium alloys to variations in casting temperature, also, has probably been taken into consideration, and the procedure regulated accordingly.

Mechanical Treatment.

It may now be pointed out that the effect of mechanical treatment has also to be taken into account in considering Duralumin, and in this connection it may be re-called that in past experiments with the nickel-aluminium alloys mentioned earlier, the tensile strength of the cast specimens was raised from 11 to 13 tons up to 20 to 22 tons per square inch. This in itself is a remarkable result, even though it does not come up to the figure quoted for Duralumin. But it may be remarked that in the case of the nickel-aluminium alloy these results were not obtained by any chance founder under ordinary conditions; they were the result of close attention by a firm who specialised in the work (the Pittsburg Reduction Company), and employed every means to get the best possible results.

While on the subject of mechanical treatment, it is interesting to note that the results obtained from rolling and drawing the two best of the Al-Cu-Mn. alloys experimented with by the Alloys Research Committee are given as being somewhat disappointing, an alloy approximating to the one previously quoted, with a composition of Cu. 2.06 per cent., and Mn. 1.94 per cent., giving only 17.04 tons per square inch ultimate stress on being hot rolled to $\frac{13}{16}$ in. But here again a distinct advance was recorded, fully illustrating the fact that mechanical treatment is a very influential factor. A most important fact was established, however, namely, that a comparatively small rise in the temperature of pouring will greatly reduce the strength of the casting.

When all the foregoing points have been considered, Duralumin may be robbed of some of its mystery, but it still remains a remarkable example of the metallurgical art, and one that has not been reached before by similar alloys. That it has a great future before it is quite probable, but it is also very likely that it will remain rather a metal for forging, rolling, and drawing than become a foundryman's alloy. At the same time it would be interesting and useful to see what results could be obtained by a similar alloy in general foundry practice.

TURNING SMOOTH ON THE PATTERN LATHE.—It sometimes happens with large pieces that have to be turned smooth on the face when fast on the face-plate of the pattern lathe, that there is a tendency for the tool to dig in, especially where the roughing has been carelessly done. This spoils the appearance of the work, and interferes with obtaining the desired thickness. To lessen this evil in this particular, take a common plane-iron and gash its cutting edge with an emery wheel (or, having drawn the temper, with a file) taking care that the teeth thus made are not of the same width, or else that they have different spacing, and, of course, preserving the same length of teeth for all. This tool cuts very sweetly when used in connection with the hand-rest, and if drawn from the centre towards the circumference, the circular or spiral grooves which otherwise would be made, are obliterated. If the usual fore-iron be used therewith, the work will be still better.

The Production of Alloys of Nickel and Cobalt with Chromium.*

By Elwood Haynes.

The history of cobalt is similar to that of nickel, excepting that the compounds of cobalt were used in the arts instead of the metal itself. In fact, but little was known of the metal until 1857, when Deville produced the pure metal in practically the same manner that nickel was prepared. It was found that cobalt was even stronger than nickel, possessing a tensile strength of about 65,000 lbs. per square inch. Indeed, up to that time it was the strongest pure metal yet discovered, and it still holds this position, with the possible exception of tantalum.

In 1905 the author made some experiments, with a view to utilising the alloys of cobalt and nickel with chromium for ignition points in connection with gas engines, and was soon able to produce both the alloys of nickel and cobalt in considerable quantity. The nickel-chromium alloy could be worked cold, while the cobalt-chromium alloy must be worked hot in order to obtain any degree of satisfaction.

The author purchased a considerable amount of pure cobalt and pure chromium and had a mixture of nearly equal parts of these metals fused in an electric furnace, the metals being placed in a carbon crucible lined with pure magnesia. The alloy was cast into a small bar, about ¼ in. square and 5 or 6 in. long. This alloy exhibited most of the characteristics of that previously obtained by reduction with aluminium, but it could not be drawn to any extent under the hammer without cracking. This might be due to the high percentage of chromium or to slight impurities in the metals employed.

In order to determine what the effect of alloying the cobalt with smaller percentages of chromium would be, the author had recourse to the gas furnace and succeeded in melting a mixture containing 75 per cent. cobalt and 25 per cent. chromium in a crucible. This alloy melted to a perfect fluid and was poured into an ingot mould, which gave a bar of metal about ½ in. square and 5 or 6 in. in length. This metal proved to be very sonorous and elastic and, if some care were used, it could be hammered out into a rough strip.

After a considerable amount of experimenting with various purifying agents, the author finally succeeded in producing a very tough and malleable alloy, which could be hammered into the thinnest sheet at a bright red heat without showing any signs of cracking. A razor blade was made from a bar of the alloy, and while it did not prove equal to the best steel for this purpose, it has been used hundreds of times for shaving purposes and, after a year and a half, shows practically no signs of wear, though, of course, it has been necessary to strop it frequently in order to keep it in good condition.

A test of the tensile strength and elastic limit of this material showed an elastic limit of 79,000 lbs., tensile strength 96,000 lbs., and elongation 3 per cent. It will be seen from the above that both the elastic limit and tensile strength of this material are superior to those of untreated steel, resembling more nearly those of good nickel steel. The elongation is quite low, but this is to be expected, on account of the great hardness of the alloy, which is equal to that of mild tempered tool steel. A test was also made of the modulus of elasticity of this material, which was found to be about equal to that of steel. This is a very significant fact, since heretofore it has not been possible to form an alloy of non-ferrous metals which would show a modulus of elasticity comparable to that of iron and steel. It is lack of this valuable property in various non-ferrous mixtures which renders them inferior to iron for many important purposes.

By mixing the alloy with small quantities of other substances, its properties may be modified to a remarkable degree. By this means, the author has obtained alloys or combinations which, while very brittle, would readily scratch quartz crystal.

By reducing the quantity of chromium to some extent and adding certain other materials, alloys which are practically proof against nitric acid can readily be obtained, which are sufficiently soft and malleable to be worked cold, having a hardness not much greater than that of mild untempered steel.

The colour of the alloy lies between that of steel and silver and is specially pleasing in bright light. The alloy is also readily polished, but requires special treatment in order to develop its highest lustre.

The most remarkable property of this combination, however, is its resistance to corrosion. It is equalled in this respect only by gold and the metals of the platinum group. It is attacked slowly by dilute hydrochloric acid and somewhat vigorously by the strong acid, especially when heated. Momentary exposure, however, to either dilute or strong hydrochloric acid has practically no effect upon the metal. Both strong and dilute sulphuric acid attack it very slowly when cold and not very rapidly even when heated. Nitric acid is totally without action upon it, and a polished piece of the alloy may be boiled in it for hours without affecting the lustre of the metal.

Solutions of the caustic alkalies are also totally without action upon it, even when boiled for hours. The alloy is likewise proof against all atmospheric influences, whether the air be moist or dry, and retains its brilliant lustre for months or even years, under severest conditions. Even sulphuretted hydrogen, when present in the atmosphere in large quantity, is totally without influence upon it.

It can readily be melted in an open crucible in a gas furnace, with practically no oxidation, so long as a slightly reducing flame is maintained. This is all the more remarkable on account of its high melting point, which seems to be about 1,650 degrees C. for the 25-per-cent alloy. Indeed, the metal has been melted in this manner with a loss of less than one-half of 1 per cent.

This material is particularly suitable for all kinds of small cutting instruments. It is especially adaptable to the manufacture of pocket-knives, on account of the beauty of its colour and the brilliancy of its lustre, both of which remain permanent under all circumstances.

Alloys in certain proportions will also doubtless find a wide use for surgical instruments, since they resist perfectly all sterilising solutions. The alloy is perhaps better adapted for table cutlery than anything that has ever yet been produced.

* Abstract of Paper read before the American Chemical Association, San Francisco meeting, July 16, 1910.

Sæculoria Bronze.

Sæculoria bronze is an alloy now being placed on the market by the Sæculoria Bronze Company, Derwent Street, East Greenwich. The alloy is made in two main varieties, namely, bearing or anti-friction bronze, and malleable bronze.

The Bearing Alloy.

The chief and most important feature of the bearing bronze is its resistance to crushing. Owing to its composition this bronze with moderate lubrication will not run hot under the ordinary conditions of working at any speed or with any weight of shafting. The metal, it is claimed, is thoroughly homogeneous and of a uniform texture, and the castings are perfectly sound. Castings can be machined with ordinary tool steel.

Besides being suitable for either light or heavy bearings for shafting run at any speeds, Sæculoria anti-friction bronze is claimed to be especially suitable for cogs, mitres, worms, and worm wheels, and, in fact, under any conditions where there is great friction.

The specific gravity of Sæculoria anti-friction bearing metal is quoted as 9.248, and the resistance to compression or crushing force, according to tests, is given as 49.02 tons per square inch. This compares most satisfactorily with the crushing strength of the soft white anti-friction metals, or even with the bronzes.

The Malleable Alloy.

Sæculoria malleable bronze is claimed to be much lighter and stronger than the manganese bronzes in general use, and superior to them in every respect. It can be forged into any shape, rolled cold or hot, and works under the hammer almost as freely as wrought iron. It will neither oxidise nor corrode in salt water. Castings of this bronze are said to leave the sand perfectly clean and smooth. This alloy is made in three different grades of quality, each being adapted to specific purposes. The first is suitable for castings or forgings, and can also be rolled into sheets or drawn into bars or wire. It is adapted for springs, piston rings, piston rods, valves, plungers and plunger rods, valve seats, etc., and is efficient for any purpose where plates or sheets are required. The second quality is made for hydraulic purposes, and where a perfectly close and homogeneous metal is required, including hydraulic cylinders, valves, valve seats, cocks, and unions for heavy hydraulic work. The third quality is a soft, tough bronze suitable for propeller blades, which, owing to the strength and lightness of this metal, can be made about 40 per cent. lighter than those at present in use, the cost being proportionately less. It does not oxidise in salt water, but the surface becomes brighter by use. The blades can be forged to any degree of fineness after casting, and will not fracture or break off in any ordinary case of damage, but will only bend, and can easily be forged back into shape again. This grade is also suitable for the manufacture of rails, bars, angles, etc.

The specific gravity of this malleable bronze is quoted as 8.411, and it is stated that a sample was tested for compression, and the compression resulting from a pressure of 100,000 lb. per square inch was 10.45 per cent. The specimen was "very slightly marked." A sample was also tested for tensile strength, the ultimate stress being 62,700 lb., or 28.0 tons per square inch. Two samples were tested for compression, and one showed a maximum stress of 138,969 lb., or 62.04 tons per square inch, and the other a maximum stress of 140,828 lb., or 62.87 tons per square inch. Two bars of the malleable bronze were tested for bending, the breaking load of the first bar, which was 1.012 inch diameter, was 15,456 lb., or 6.90 tons, and that of the second bar, which was 1.007 inch diameter, was 14,873 lb., or 6.64 tons.

Metal Cutting by Oxygen and Acetylene.

During the last few years oxygen has come very prominently into use for the purpose of cutting wrought iron and steel plates and structures of all sorts. The process is based on the well-known fact that a jet of oxygen directed upon a previously heated spot of metal ignites it, with the result that the metal acting as its own fuel burns away rapidly in the form of iron oxide. The same process was practically applied to the opening up of tuyeres in blast furnaces which had become blocked by the solidification of metal.

The use of oxygen for this purpose proved so successful that its value in the cutting of metal was again suggested. Theoretically, once iron is ignited in oxygen, if a powerful jet of the gas is maintained in operation, it should be possible to burn away the metal without any auxiliary source of heat. Oxide of iron, however, is formed at a comparatively low temperature and lacks fluidity. It was found difficult in pratcice to eliminate all the oxide which was formed. Much of it adhered to the partially-molten metal thus preventing the intimate contact of metal and gas, with the result that combustion soon failed and the cutting operation was arrested. The process was in consequence intermittent, the consumption of oxygen wasteful, and the cut wide, coarse, and irregular. A cutting blowpipe, which is a very simple solution of this difficulty, was subsequently introduced. It consists essentially of a blowpipe with an additional passage through which an independent and separately controlled stream of oxygen is supplied at the discretion of the operator. This separate supply of oxygen may be discharged through the centre of the blowpipe, in which case the mixed gases employed for heating are conducted through an annulus surrounding it, or the supply may be brought in a passage immediately behind the heating flame. The latter is the method preferred, and for oxygen cutting machines it is probably the best, and most economical in gases. For the ordinary hand cutters, however, the difference in construction is unimportant, and each method is equally suitable.

This simple expedient of maintaining an independent heating jet in operation whilst the cutter is travelling renders the cutting operation continuous. It furnishes the quantity of additional heat necessary to render the oxide fluid so that it can be blown away through the cut by the separate jet of oxygen, and the heating is so rapid and local that a clean, narrow cut is effected through the metal without any deteriorating effect upon its quality and at a speed of travel which is comparable with hot sawing.

Silicon Steel.

The value of silicon as a content of steel is becoming more widely recognised year by year. It is understood that high-silicon steel was largely used in the construction of the "Mauretania" and "Lusitania," the requirements being about as follows:—Ultimate tensile strength, 74,000 to 85,000 lbs. per square inch; elongation in 8 in., 18 per cent. The United States Navy requirements are:—Minimum tensile strengths and elongations of 60,000 lbs. and 25 per cent. and 75,000 lbs. and 17 per cent. for medium steel and high-tensile strength, respectively. Steel manufacturers have found that the requirements for high-tensile steel can be met much more readily by high-silicon than by high-carbon steel; consequently high-silicon is now furnished regularly on all high-tensile steel contracts.

Foundry Plant and Equipment.

The Farwell Pneumatic Moulding Machine.

In Fig. 1 is shown the latest Farwell moulding machine, made by the Adams Company, U.S.A. This apparatus is not designed to compete with the Farwell squeezer, but to handle larger work and patterns of more difficult draft, that would ordinarily require a stripping plate or that could not easily be squeezed.

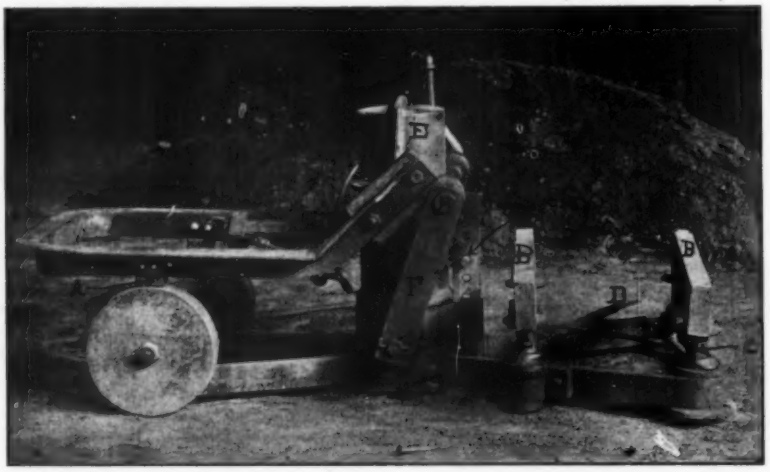


FIG. 1.—FARWELL PNEUMATIC JOLTING AND ROLL OVER MOULDING MACHINE.

It combines in one portable machine, controlled entirely by air and operated by one man, the jolting, rolling over, drawing the pattern and rapping same, an Adams pneumatic rapper being employed for rapping.

One of the greatest of the difficulties encountered with the roll-over type of moulding machine is in rolling the mould over and drawing the pattern without cracking the mould. This results from the unevenness of the bottom board, which will not rest true upon any surface, and the trouble is only eliminated by the use of self-adjusting plungers. These are employed on the Farwell machine, and allow for any inequality. They are firmly clamped by means of a single lever, which the moulder operates with his foot while his hand is still on the air valve controllng the movements of the machine.

Referring to Fig. 1, A is a heavy block bolted to the table or arm which carries the pattern. These blocks are the parts that receive the shock when the mould is jolted, dropping upon the solid cast-iron wheels which form the anvils. B designates cross pieces which are brought in contact with the bottom board by the foot treadle (D), affording a rigid foundation for the mould while the pattern is drawn. The levelling device eliminates the use of springs entirely. After the mould has been turned over and comes to rest, the mould-supporting device is forcibly brought in contact with the bottom board, conforming to any inequalities thereof. E is the cylinder which is raised by air pressure upon the stationary piston,

FIG. 2.—JOLTING; THE SOLID WHEELS RESTING ON PLANKS IMBEDDED IN THE FLOOR.

FIG. 3.—ROLLING OVER; BOTTOM BOARD SECURED BY ADJUSTABLE HINGED CLAMPS.

which is secured to the base of the machine. F is a yoke surrounding the piston below the cylinder, with which it moves except as regulated by the pin G. G is a pin adjustable to several positions to regulate the height to which pattern is drawn straight before being rolled over. H is the pin that acts as a fulcrum in rolling over the mould, the power being applied in the cylinder E.

The jolting operation is shown in Fig. 2. This is accomplished by admitting air to the cylinder and releasing suddenly, which operations are controlled by the same air valve, operated by a single lever as shown. In jolting, the pin G is placed in the lower hole, which causes the mould to rise and drop quickly. The pin in then raised to the proper hole before the mould is rolled over.

The operation of rolling flask over is illustrated in Fig. 3, also showing the bottom board clamped in position by means of the adjustable clamps which are hinged to the match board. The mould is raised, rolled over, and lowered upon the adjustable support quickly, with no danger of shock and without assistance from the operator, other than the manipulation of the air valve. There is no chance of the mould going over too suddenly, as the air that raises it to central position must be exhausted before the mould will settle down on to the cross pieces that are provided to support it while the pattern is being drawn. As the arm passes the centre, the operator opens

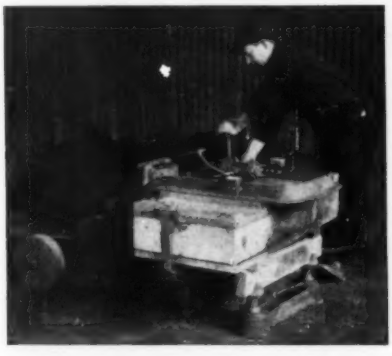


FIG. 4.—MOLDER CLAMPING SUPPORTING PLUNGERS; LEVER OPERATED WITH LEFT FOOT.

the air valve, exhausting the air that raised the mould, allowing it to drop as rapidly or as slowly as is desired.

Fig. 4 shows the operator in the act of clamping the four plungers that ensure an equal bearing at each of the four corners of the flask. This he does with his foot just as the mould has settled into position, one lever clamping all four plungers instantly. After the clamps that secure the bottom board have been released, the pattern is drawn. The moulder operates the air valve as before, but set at a position that admits air very slowly, drawing the pattern straight, while it is vibrated by means of the pneumatic rapper mounted on the arm or table that carries the pattern. Air is admitted to this rapper through a pet cock, which the operator opens with his left hand, while controlling the lift of the pattern with his right. After the pattern has been drawn far enough to ensure a safe lift, the rapper is shut off and the main air valve opened wide, quickly rolling the pattern over into position to start the next mould.

Some German Moulding Machines.

(*Continued from page* 609.)

Machine for Moulding with One Pressure.

Fig. 5 shows a machine for making complete moulds with one pressure, suited for large articles in large quantities. It is so constructed that both the upper and lower flasks can be rammed at the same time, taken off the patterns, fixed together, and taken out of the machine, completely finished. The illustration shows the two halves of the flasks ready rammed and separated from the patterns placed on both sides of the pattern-plate carriage. The sinking of the plunger with the lower flask moves the upper flask automatically upwards; its rising, on the contrary, moves it downwards. By taking the pattern plate from under the machine the flasks can be put together, taken away, and then cast.

The machine is worked in the following manner:—The lower flask is placed upon the piston plate and filled with sand, the pattern-plate carriage run in

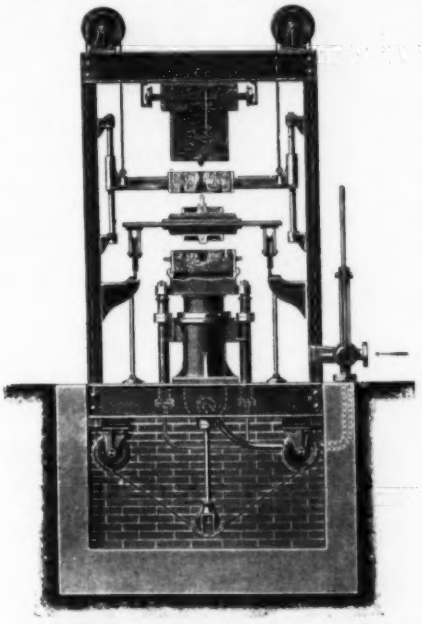


FIG. 5.—MACHINE FOR MAKING MOULDS WITH ONE PRESSURE.

position and the plungers put under pressure, until the lower flask touches the pattern plate. The top flask is then filled with sand. After this the distributing valve is opened completely, and both flasks will at once be completely rammed. The sinking of the plunger separates the rammed flasks from the patterns in such a manner that the lower flask moves downwards and the upper one automatically upwards; then, as shown in the illustration, they remain in their position. The pattern plate is shifted out and the pressure applied to the plungers. The plungers rise carrying the lower flask; at the same time the upper flask moves downwards and both flasks are set together on the machine. The finished mould is taken off the machine and cast.

In this machine the work is done automatically by only one distributing valve, so that a mistake in the

working cannot take place and accidents are avoided. avoided.

Machine for Mak'ng Moulds without Flasks.

The machine shown in Fig. 6 is constructed to make moulds without flasks, and is particularly suited for the moulding of small parts of agricultural and sewing machines, etc. The machine consists chiefly of the following essential parts:—(1) A removable table with pattern plates screwed on both sides; (2) an upper and a lower flask which remain always on the machine; (3) a piston connected with the lower flask, so that the flask automatically follows the movement of the piston on the up and down stroke; (4) two rigid columns with cross connection in the upper part to which a press block is attached; (5) a shaft with fish-hook supports attached to it, which catch the upper flask in order that the finished mould can be rammed through.

The operation of the machine is effected in the following manner:—Before the operation starts, the pattern table has to be swung out so that there is

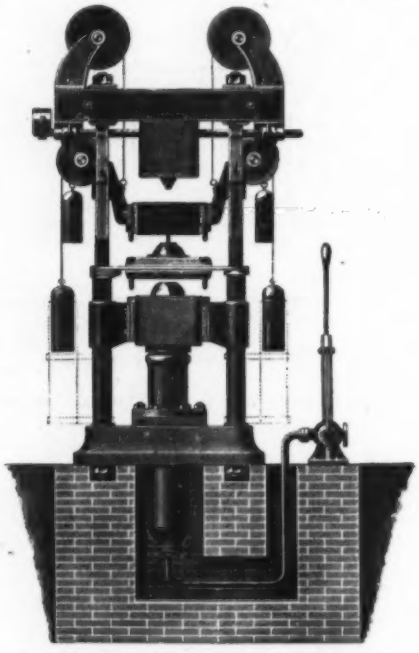


FIG. 6.—MACHINE FOR MAKING MOULDS WITHOUT FLASKS.

nothing between the upper and lower flask. In the lower flask is placed a wooden plate of the size of the flask and of about 1 in. thick; this plate serves to carry the complete mould to the upper rim of the upper flask after the operation is finished. When the lower flask has been filled with sand, the pattern table is replaced. The distributing valve is then opened, and the lower flask moves upwards, the upper flask at the same time moving downwards, until both flasks touch the pattern table. The upper flask is then filled with sand, and the piston put under pressure completely rams by one uninterrupted stroke the upper and the lower flask with the pattern table between. After discharging the pressure, the lower flask is taken off the pattern downwards, and the upper one automatically upwards. Then the pattern table is again swung out, and by opening the distributing valve, the upper and the lower flask are automatically coupled. The upper flask is held by a special arrangement in its position, so that the complete mould consisting of sand is rammed through the flasks by the inner piston to the top rim of the upper flask, where the mould is taken off by hand and can then be cast. After discharging the pressure the machine returns automatically to its first position.

Both of the foregoing machines are by Messrs. Bopp & Reuther, Mannheim-Waldhof, Germany.

An Electrically Heated Glue Pot.

An interesting example of the modern application of electricity in the pattern-shop is illustrated herewith. The "Aston" electric glue pot, made by Messrs. Veritys, Limited, Aston, Birmingham, has many points of excellence as regards cleanliness, reliability, rapidity of melting, etc.; while it is also claimed to be an economical apparatus. The heating element is easily replacable, and the heat is subject to four degrees of regulation.

THE "ASTON" ELECTRIC GLUE POT.

As regards the power required, one-pint pots are made to take 100-110 volts, 200-220 volts, or 230-250 volts. The same range is obtainable in the larger size, the capacity of which is $2\frac{1}{4}$ pints. The weight of the smaller pots is $4\frac{1}{4}$ lbs. and that of the larger size $6\frac{3}{4}$ lbs.

THE PRIDMORE ROCK-OVER CORE-MAKING MACHINE.—In our last issue we published particulars of this core-making machine, the maker of which is Henry E. Pridmore, of Chicago, U.S.A. The sole agents in this country for the machine, we may mention, are Messrs. J. W. Jackman & Company, Limited, Caxton House, Westminster, S.W., at whose Manchester house it may be seen in operation.

SIR ROBERT HADFIELD, who is in the United States, has been informed by the Chairman of the Committee of the Franklin Institute that he has been awarded, for distinguished and leading work in the science of metallurgy, the "Elliott-Cresson" gold medal.

Malleable Cast Iron.

By J. Peers.

Speaking from a practical standpoint the furnace best adapted for making malleable cast iron is the air furnace. It gives good results on account of the fuel not coming in contact with the metal and absorbing the sulphur, which is a bad content in malleable cast iron. Sulphur in high percentages must not be permitted in large or long, thin castings, but for small work it can reasonably be present. As example, a casting $\frac{5}{16}$ in. sectional thickness, containing 0.5 per cent. sulphur took 3½ days to anneal, and a similar casting with 1.5 per cent. sulphur, took over 6½ days to anneal; it is, therefore, very plain that this would mean a large item in the annealing costs.

The charging, rabbling, slagging and testing should be done strictly to time, with a charge sheet similar to the following:—

No. *Furnace* *Date*

Charged at H. M.	Slagged at H. M.	Tapped at H. M.	Description of Charge. Brand of Pigs.	Heats. 1	2	3	4
			A				
			B				
			C				
			D				
Remarks—			E				
			F				
			Scrap				

If possible, more than one air furnace should be in use where the work is done in large quantities and is of a varying character, the reason being that different charges are required to suit the sectional thickness, it being almost impossible to get anything like uniform returns or to do away with a lot of the failures unless this principle is adopted. More than one furnace is advocated on account of the silicon content, which has a very important effect on the strength of the castings. Work of thick section should not have more than 0.4 per cent. silicon; work of about ½-in. section not more than 0.9 to 1 per cent. silicon. With less than 0.8 per cent. silicon the annealing is done in less time, and with 0.8 per cent. silicon the annealing takes longer. For very thin work, such as saddlery and harness work, silicon may be used up to 1.25 per cent. The element to introduce to make thin castings run is carbon. The minimum amount is about 1.5 per cent. With less than 1.5 per cent. a very poor product is obtained as the result of a lack of fluidity. With too high carbon the castings will not be so strong; the medium is about 2.95 per cent. carbon. Phosphorus will interfere with the annealing by forming a eutectic, and a phosphide may be formed and cause the castings to be brittle; therefore, the phosphorus should be as low as possible. In the presence of sulphur manganese should be as low as possible. Heavy castings, on account of the shrinkage, should have a charge composed of 75 parts of a suitable pig-iron to 25 parts of hard scrap.

With regard to moulding, this is somewhat different to moulding for cast iron, although it is often stated to be similar. More coal dust is required in the sand, and, further, anyone that has been used to common cast iron, on taking up malleable cast-iron work will, at the outset, have the work scabbed in front of the runners. A good moulder would naturally think he had either got the face of his mould too hard, or that he had not vented it properly, or that his sand was not strong enough. If the metal is being spun in by one or more spinners, the mould should be sprinkled with water in front of the spinners; that is, where the metal has to play on a surface at all flat, using the water with judgment or the casting will be blistered. The water is sprinkled on because the metal is very fierce in this particular spot, and fuses the sand. The gates used in malleable cast iron are quite different to those for ordinary castings, it being sometimes better to use spray gates, and at other times a spinner or several spinners. The man in charge should direct where gates and feeders should be placed, for this is a most important feature in the work, and they should be distributed about the casting according to size and shape. Top feeders of a style which has lately come into vogue for use on a flat surface, are termed "core feeders," being made in the core shop and dried. These are placed on the pattern after the joint is made, and rammed up in the cope. They save a lot of cutting, and break off quite close to the casting, saving time in the moulding and grinding. They resemble a basin with a suitable sized hole in the bottom, and the angle is put on by the moulder just scraping the bottom side of the hole. They are made in different sizes according to the size of feeder required.

Another important feature is the tying together of lugs and brackets to prevent pulling, which would occur no matter how soon they were placed in the oven or muffle. By this method many castings are saved. All these items play as important a part as the mixing of metals.

The castings should be well cleaned and inspected before going to be annealed, and no casting should be passed unless it is sound, for returned annealed castings are a bad quantity, and receive the name of "soft scrap." This is very difficult to melt on account of the silicon being in the silica state. The best way to remelt this soft scrap is by the air furnace, but it is far better if it can be left out altogether.

British v. Foreign Moulding Machine.

In a recent issue a correspondent in discussing the question of the moulding machines which were used in British foundries, made some reference to those installed at the Daimler Motor Company's Works, remarking "It would be interesting to learn what the Daimler Company themselves think of these (five Coventry machines) English machines, compared with the foreign machines they have in use." In this connection it will not be out of place to quote a letter from the Daimler Company to the Britannia Foundry Company, Coventry, the makers of the English machines in question. The Daimler Company write;—"We take this opportunity of saying how pleased we are with the machines of your make which we have already installed, and can thoroughly endorse the claims you make for them. We have no hesitation in saying that they are superior to any of the other makes of moulding machines which we have in our foundry." It may be noted that the Daimler Company's foundry plant includes a number of the latest and most expensive pneumatic, hydraulic and jarring moulding machines.

Inventions.

Applications for Patents.

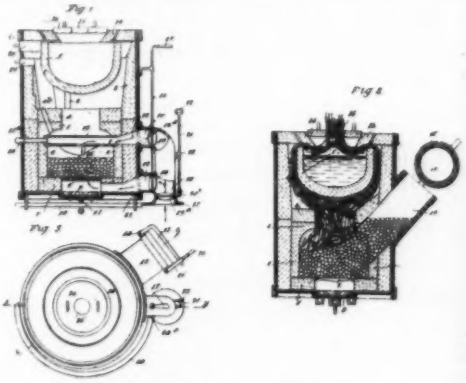
An asterisk indicates that a comp'ete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

21,098. Stopper for foundry ladles. W. J. Caulfield.
24,132. Core-boxes. E. Dickinson and J. E. Short.
24,276.*Device for removing the moulds in the production of ingot iron. G. Marton.
24,304. Cupola tuyeres. M. E. Gallon, Victoria House, Dunston-on-Tyne.
24,329. Melting furnace. G. J. Stock.
24,491.*Regenerative furnaces. P. Veeckmans.
24,590.*Cupola furnaces. P. Anderson.
24,750. Furnaces for heating, annealing, roasting, smelting, etc. A. Smallwood, 5, Corporation Street, Birmingham.
25,240. Casting, boshing, and transporting of ingots, wire bars, etc., of copper or alloys. G. Deer and F. J. Taylor.
25,503. Machine for reducing metals to liquids and transferring them to dies and moulds. P. Bishop and E. H. Bolton, 14, Balfour Avenue, Hanwell, London.
25,823.*Gas hardening and tempering stove. J. Green.
25,844.*Casting ingots. E. Gathmann.
26,039.*Machines for shaping, planing, and slotting metals. Wm. Muir & Company, and J. H. Melloy.
26,295. Machinery for grinding or surfacing metallic bodies. J. Dronsfield, 5, John Dalton Street, Manchester.
26,335.*Manufacture of steel and iron. T. W. Smith.
26,384.*Production of metal pigs and castings. W. Muirhead. 96, Buchanan Street, Glasgow.
26,405. Heated shaking or tumbling barrels. T. A. Stevens and F. C. Sharp, c/o Arnold & Large, Limited, Green Lane Foundries and Engineering Works, Wolverhampton.
26,751. Metal-casting machines. E. I. Everett, Collindale Works, Hendon, London.
26,809. New method of casting metals into moulds. W. Whitehouse, 139, Victoria Street, Westminster.

Abstracts of British Patent Specifications recently accepted.

9,406 (1910). *Manufacture and Treatment of Steel.* H. A. Richardson, Hyde Park Hotel, Knightsbridge, London S.W.—The invention consists in forming the plates or articles from ingots made from an alloy containing 2½ per cent. of tungsten and about 0.2 to 0.5 of carbon, and subjecting such plates or articles to a cementation process, whereby a glass-hard surface is produced without quenching. In carrying the invention into effect according to one modification, an alloy containing tungsten 2½ per cent., nickel 4 per cent., and carbon 0.3 per cent. is prepared by any suitable melting process, by which a pure steel free from phosphorus and sulphur can be obtained. For the purpose of the manufacture of armour-plates, the ingots of this composition are rolled to the desired thickness of plate, and the plates covered with oak charcoal or other carbon on one surface, and carbonised, as is usual in the cementation process.

27,609 (1909). *Crucible Furnaces.* L. Rousseau, 116, Quai de Seine, Argenteuil, France.—Figures 1 and 2 are sectional elevations made respectively on the lines A—B and C—D of Figure 3; Figure 3 is a plan view. 1 is the crucible, supported by radial supports 2 suitably distributed on its circumference, and supported on the internal lining 6 of the furnace. The supports 2 are supported below on a crown 4, supported by an arch 5 formed by a double internal lining 6 of refractory material, with which the lower part of the furnace is provided. This second internal lining 6 rests on a bottom 7 pierced by a central hole, and provided with the grate 8. The central hole of the bottom 7 is internally obturated by a plug 9 lined with refractory material, and maintained in position by a cross piece 10 and a screw 11. The charging of the furnace is effected by means of an inclined shoot 12, arranged at the side of the furnace, and joining the lower part of the furnace below the arch 5. The shoot 12 is closed by a cover 13, mounted on hinges 14 and maintained in position by an articulated lever 15 of the form of a stirrup, which is provided with an operating handle 16. The part of the cover 13 which comes in contact with the upper extremity of the shoot 12 is provided with an amianthus lining 17, designed to ensure the tightness of the joint of the cover 13. The cover 13 is shown in Figure 2 in an open position in order to show the amianthus garniture 17. The introduction of the air necessary for the combustion of the fuel takes place through a vertical conduit 18, which is divided in two branches 19 and

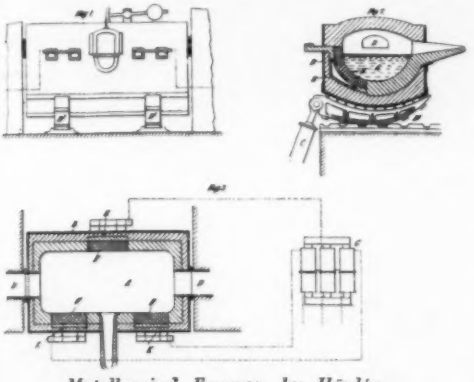


Crucible Furnace, by Rousseau.

20. The branch 19 is extended by a hole 21 made in the lining 3 and in the bottom 7 of the furnace and issues below the grate 8. The branch 20 is extended by a hole 22 made in the lining 3 and in the internal lining 6, and issues immediately below the arch 5, opposite a tube 23 of preferably circular section and diametrically arranged inside the furnace. The tube 23 is made of refractory material, preferably of plumbago; and is connected at its extremity opposite the hole 22 with a pipe 24 by a perforation 25ª made in the linings 3 and 6. The other end of pipe 24 is joined to the branch 20 at 24ª shown in Figure 1 in dotted lines. The tube 23 is provided with holes 25 arranged at suitable distances apart. A rod 26 provided with a handle 27 carries two dampers 28 and 29 to allow of regulating the passage of the conduits 19 and 20; the dampers 28 and 29 are keyed on the rod at an angle of 90 degrees to one another, so that, if one conduit is completely open the other is closed, and if the opening of one of these conduits 19 or 20 is increased the opening of the other is reduced. The conduit 18, designed to receive the air by its lower extremity, is provided below the branch 19 with a damper 29 mounted on a lever 30 to which a vertical rod 31 is articulated. The rod 31 traverses a guide support 32, and can be raised or lowered by means of the handle 33. By lifting or lowering the rod 33 the angular position of the damper 29, and consequently the section of the passage of the conduit 18 can be varied.

3,739 (1910). *Metallurgical Furnaces.* J. Härdén. The Grondal Kjellin Company, Limited, 20, Abchurch Lane, London, E.C.—Figure 1 is a front elevation, Figure 2 a sectional elevation, and Figure 3 a sectional plan of an open-hearth furnace provided with means for electrical heating in accordance with this invention. Figure 3 also includes in dotted lines a representation of the means for supplying electric current to the furnace. A represents an ordinary rectangular open hearth slightly deeper than is customary, and built up in a casing B, which is adapted to be tilted on a

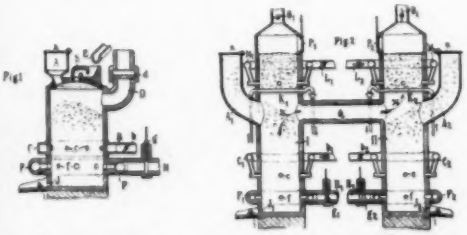
bed plate B^1 by a tilting contrivance C. D, D are the usual ports through which the gas and air to be burnt are introduced. In the wall of the furnace, composite terminal plates are built; these plates each consist of a cast-steel plate E, adapted for the circulation of air or other cooling medium in contact with it, and a facing F of second-class electric conducting material; that is to say, material which becomes electrically conducting when hot; this facing should form part of the lining of the furnace so that the molten material may



Metallurgical Furnace, by Härdén.

come into direct contact with it. To enable the plate E to be cooled by the circulation of a cooling medium, it should be made hollow. Between the cast-steel plate E and the layer F, a layer of material of intermediate electrical conductivity may be provided. The plates are connected to a suitable source of electric current in the usual manner. In the construction illustrated, three terminal plates are shown embedded in the furnace wall for use with a three-phase current supply derived from a transformer G, but it will be understood that any other appropriate system of electric power supply may be used.

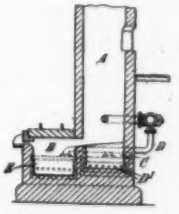
19,764 (1909). *Process and Apparatus for the Production of Metals.* F. C. W. Timm, 86, Wandsbeckerchaussee, Hamburg, Germany.—The metallic compounds concerned together with any mixtures or necessary additions are converted into a fluid mass, which is conducted into a furnace filled with pieces of fuel previously heated to a high temperature whereby the metallic reduction is effected. As soon as the reaction proceeds too slowly, the heat required for the reduction of the metallic ores having been withdrawn from the fuel, whose temperature falls in consequence, the supply



Process and Apparatus for the Production of Metals.

of the fluid mass is stopped and air is conducted through the furnace. After a certain time, from two to five minutes, for example, the fuel is again hot enough to carry on the reduction. The air supply is then shut off, and the liquid mass is again run into the furnace. An apparatus suitable for carrying out the process in cases where volatile metals are to be obtained, is shown by way of example in Fig. 1 of the accompanying cut. The fuel is introduced into the furnace through the funnel A provided with a closely fitting lid *a*, and is always kept at the same charging level. The air for combustion enters by the pipe B when the valve *b* is open, into the circular channel C, and from this it reaches the furnace through several orifices *c* and part of the fuel, according to the pressure and temperature, burns and evolves carbonic acid or carbon monoxide. The gases thus produced leave the furnace through the chimney D when the slide *d* is open. The fluid mass to be reduced runs along the trough E and reaches the furnace through a seal or trap S, and the slag freed from metal leaves the furnace through the tapping hole J similarly provided with a seal or trap *i*. The metallic vapours, and gases, such as carbon monoxide, produced in consequence of the reduction, pass through several orifices *f* into the circular channel F and are condensed as liquid metal in a condenser connected at the point H, or are allowed to escape if not capable of condensation at the temperature of the condenser. The slide *g* is opened during the reducing process, but is closed whilst blowing takes place. The drawing shows the positions of the various closing devices during the operation of reducing the metal. If blowing is to take place, the supply of the fluid mass is stopped, the valve *b* and slide *d* are opened and the slide *g* is shut. Figure 2 shows another apparatus for carrying out the invention.

16,940 (1909). *Manufacture of Steel.* T. J. Heskett, Great Eastern Hotel, Calcutta, British India.—In the annexed cut A is the cupola, which is connected to the converter B in such manner that molten metal in the cupola may flow into the converter, and there be converted into Bessemer steel. Instead of the molten metal in the cupola passing directly into the converter, however, it accumulates in a well or bath C formed in the base of the cupola, and on overflowing passes into the converter. Connected to the conduit D which leads blast



Manufacture of Steel.

to the converter B, is a blast box provided with tuyeres D^1 leading into the well or bath C, this blast box and connected tuyeres being similar to the blast box and tuyeres of the converter. From the foregoing description it will be understood that in operation the molten metal which accumulates in the bath C and overflows continuously into the converter B, is treated in the bath for the oxidation of silicon, manganese and other matter, so that the metal passing into the converter is more or less pure and homogeneous. To ensure a sufficiently high temperature being maintained in the converter additional air tuyeres may be placed above the steel bath to burn the carbonic oxide constantly being evolved.

EDGWICK WORKS FOUNDRY, COVENTRY.—On page 597 of our last issue, in dealing with a recent visit of the British Foundrymen's Association to the Edgwick Works of Messrs. Alfred Herbert, Limited, we stated that these works are devoted chiefly to the manufacture of *rolling* machines. This should, of course, read "milling machines," for the manufacture of which the firm have a world-wide reputation.

Trade Talk.

Mr. J. Moorwood has acquired the Eagle Foundry, Attercliffe Road, Sheffield.

Messrs. Simpkin, Wilkinson & Gibson, engineers, 66, Kirkstall Road, Leeds, are reported to be relinquishing their business.

W. & T. Avery, Limited, of the Soho Foundry, Birmingham, have again secured the Grand Prix at the Buenos Ayres Exhibition.

Messrs. J. W. P. Hayton and J. W. Longley, engineers, Bradford, trading under the style of J. & C. Hayton, have dissolved partnership.

Messrs. Kater & Ankersmit, engineers, have removed from 14 and 15, Conduit Street, London, W., to Centre Avenue, Acton Vale, London, W.

A fire broke out at the River Don Works, Brightside, Sheffield, of Vickers, Sons & Maxim, Limited, recently, doing considerable damage to the gun shop.

A dissolution of partnership is notified by Messrs. C. T. Brown and J. Davys, ironfounders, Leeds, who traded under the style of C. T. Brown & Company.

Messrs. T. Johnson, J. F. Johnson, and J. Johnson, Hindley, near Wigan, engineers, etc., trading under the style of Johnson Brothers, have dissolved partnership.

Mr. R. Dunlop, 9, Redcross Street, Liverpool, has been appointed agent for Shanks & Company, Limited, Barrhead, and Walker, Hunter & Company, Limited, Falkirk.

The Flottmann Engineering Company, Limited, of Cardiff, are building additional stores accommodation and an extensive new smithy at their Allensbanks Works.

Messrs. S. Withers and J. Griffin, malleable ironfounders, etc., Walsall, Staffs, who traded under the style of Withers & Griffin, notify a dissolution of partnership.

Messrs. G. Lindsay, A. Lindsay, and J. Hodge, engineers, etc., Sunderland, trading under the style of Lindsay, Caverhill & Company, notify a dissolution of partnership.

The first annual meeting of the Society of Machine Tool Makers and Factors was held in the Banquetting Hall Reception Room, Midland Hotel, Manchester, on November 1.

Messrs. Moncrieff P. Ford & Company, machinists, tool-makers, and specialists in hardening shop equipment and supplies, have opened offices at 57, Colmore Row, Birmingham.

Mr. H. G. Keywood, C.E., of Ossett, has established himself in business as the Municipal Engineers Supply Agency. He has been appointed agent of the Clay Cross Company.

Messrs. J. C. Wardrobe and T. A. Jervis, malleable ironfounders, Sheffield, trading under the styles of Stephen Fisher & Company, and Francis Jervis, have dissolved partnership.

Royce, Limited, of Trafford Park, Manchester, have removed their London office to 13, Walbrook, E.C., and have appointed Mr. F. E. Chilton as their manager for London and District.

The London offices of W. Summerscales & Sons, Limited, Phœnix Foundry and Coney Lane Works, Keighley, have been removed to Phœnix House, Dacre Street, Westminster, S.W.

A dissolution of partnership is notified in connection with Messrs. W. Sunderland and J. H. Southwell, engineers, Cullingworth Gate, Yorks., who traded under the style of Sunderland & Southwell.

C. Churchill & Company, Limited, of Leonard Street, Finsbury, London, N., have been appointed by the Norton Company, of Worcester, Mass., U.S.A., as their British agents for the sale of Norton grinding wheels.

Several vacancies for scholarships under the Yarrow Educational Fund will occur in March, 1911, for which the Council of the Institution of Civil Engineers is now prepared to receive and consider applications.

Another International Engineering and Machinery Exhibition promoted by the proprietors of the "Engineering Review," will be held at Olympia in 1912, from October 4 to 26 inclusive.

A fire broke out on November 19 in one of the large safes at the works of the Consolidated Pneumatic Tool Company, resulting in the destruction of a large number of valuable sketch plans and drawings.

The trustee of the sequestrated estates of Mr. J. M. Collins, engineer and machine maker, 121, Swanston Street, Glasgow, intimates that he will be in a position to divide the estate among the creditors on December 31.

Mr. A. S. Bridges, trading as J. & A. Bridges, engineers and ironfounders, Rosehall, Haddington, N.B., has granted a trust deed on behalf of his creditors in favour of Mr. S. P. Sinclair, 3, Albyn Place, Edinburgh.

Webster & Bennett, Limited, of the Atlas Works, West Orchard, Coventry, have appointed the Judson-Jackson Company, 14, Great Smith Street, Westminster, London, S.W., as their London and South-Eastern agents.

Herbert Morris & Bastert, Limited, Empress Works, Loughborough, have opened show rooms at 116, Bute Street, Cardiff, and 41, Wind Street, Swansea, which are under the superintendence of Mr. R. H. Hutchinson.

J. J. Saville & Company, Limited, of the Triumph Steel Works, Sheffield, have been successful in obtaining the only Gold Medal awarded for high-speed steel and carbon steels for tools at the Industrial Exhibition held this year in Jekaterinoslaw (Russia).

Mr. J. Lord, late managing director of the British Gas Furnace and Tool Company, Limited, has established himself in premises at Summer Row, Birmingham, where, under the style of the Lord Furnace Company, he is exploiting his specialities in melting furnaces and hardening shop equipment.

The Cowper-Coles Galvanising Syndicate, Limited, who work the Cowper-Coles patents for cold galvanising and hot galvanising at their Magnet Galvanising Works, Bow Bridge, Stratford, are now adding another branch to the business, namely, coppering and brassing of iron for protective and ornamentive purposes.

Buck & Hickman, Limited, of 2 and 4, Whitechapel Road, London, E., have been appointed sole agents for the United Kingdom and British Colonies for the products of the American Emerywheel Works, Providence, R.I., U.S.A., the makers of the "A.E.W." grinding wheels and other abrasives of corundum, emery, carborundum, etc.

The extensions recently carried out at the Landore Works of the British Mannesman Tube Company, Limited, consist principally of a new building for manufacturing spigot and faucet tubes. The extensions cover an area of about 6,000 square yards, and contain the necessary plant for dealing with a considerable addition to the output.

At the London Bankruptcy Court, recently, Mr. Registrar Hood, on the application of creditors, made an order appointing Mr. E. H. Hawkins to act as joint liquidator chosen by the creditors in the matter of Andrew Handyside & Company, Limited, engineers and ironfounders, Derby. From affidavits filed it appears that the company's indebtedness is £99,000.

Messrs. Gabriel & Company, engineers and ironfounders, etc., of 4, A.B. Row, Coleshill Street, Birmingham, have just introduced a new metal on the market, which they style the "Clarus" aluminium alloy. The company claim that it is of very great tensile strength, being 60 per cent. stronger than ordinary aluminium, and is only one-third the weight of brass.

At a private meeting of representatives of the principal Scottish tube makers, held in Glasgow, recently, a scheme was put forward to combine all Scottish concerns under one association. The scheme was

favourably received, but it was recognised that it would not be effective unless the English makers were included, and it was consequently decided to take steps with that end in view.

THE date of the annual meeting of the Iron and Steel Institute has just been fixed for Thursday and Friday, May 11 and 12, 1911, and the annual dinner will be held on the evening of May 11. Excellent progress is being made with the arrangements for the autumn meeting in Italy, Monday, October 2, having been practically agreed upon as the date on which the meeting will open at Turin.

A MEETING of opticians was held in the rooms of the Chemical Society, Burlington House, on Tuesday, November 29, for the purpose of considering the advisability of promoting a second Optical Convention, the first of which was held in 1905. The chair was taken by Dr. R. T. Glazebrook, C.B., F.R.S., Director of the National Physical Laboratory, as chairman of the permanent committee appointed at the last Convention. It is suggested that the Convention should be held in 1912.

AT Liverpool University, on October 22, the foundation-stone was laid of an extension at the Engineering Laboratory, made possible by the gift of £30,000 by Messrs. F. Harrison, H. Harrison, and J. W. Hughes, of Liverpool. A feature of the work at the new laboratory, it was explained, would be that with regard to marine engineering. It was intended to make special provision for teaching and research work in connection with all branches of engineering, internal combustion engines, steam turbine engines, refrigeration, and fuel testing.

A NUMBER of engineering concerns have, during the last few months, transferred their business or established branch works in the borough of West Ham. The latest of these is the Milners' Safe Company, Limited, of Liverpool and London. This company have established new works in Carpenter's Road, Stratford, for the manufacture of steel office furniture and fittings of all descriptions. Included in the other concerns who have lately migrated to West Ham are:—James Pollock, Sons & Company, Limited, engineers, Windmill Lane, Stratford; the Cowper-Coles Electro-Zincing and Galvanising Syndicate, Limited, High Street, Stratford; and the Check-fire Door Company, manufacturers of patent fire-resisting doors, etc., Camel Street, Silvertown.

FOR some time past the Birmingham Aluminium Castings Company (1903), Limited, Cambridge Street Works, Birmingham, have been experimenting with Corporation gas as a heating medium for the crucible furnace, and as a result of these experiments a practical demonstration was given on the 25th ult., before the Lord Mayor and members of the Gas Committee when 100 lbs. of aluminum was melted in a little over an hour. Many attempts have been made to utilise gas, more especially producer gas, under pressure in the crucible furnace. Hitherto, however, the serious objection to all such methods, which necessitated the employment of blast, has been the cutting of the pots, and we believe, the Birmingham Aluminium Castings Company are the first to succeed in the application of gas in such a manner as to overcome this objection.

THE firm of Richardson, Henderson & Company, carrying on business as engineers and machinery agents, at 65, Renfield Street, Glasgow, of which Mr. J. S. Richardson and Mr. R. Henderson were the sole partners, has been dissolved. Mr. J. S. Richardson retains the agency for Marshall, Sons & Company, Limited, engineers, Gainsborough, and will carry on business in his own name as a machinery merchant and consulting engineer, at 65, Renfield Street, Glasgow, and will also discharge the liabilities of the dissolved firm. Mr. R. Henderson retains the agencies of Hathorn, Davey & Company, Limited, Kater & Ankersmit, and Peter Brotherhood, Limited, and will continue to carry on business in his own name as a machinery agent and consulting engineer at Prudential Assurance Buildings, 48, West Regent Street, Glasgow.

A REMARKABLE piece of work has just been completed by Edgar Allen & Company, Limited, of the Imperial Steel Works, Sheffield. It is a huge lay-out fan for the Kirkstall Road Depôt of the Leeds City Tramways. The lay-out is 346 ft. long, and consists of 27 bays or tracks into the depôt, each of 35 ft. radius from the main track, spiralised to suit the various distances to the "pits" in the depôt. This method has been adopted for the purpose of standardising the points and crossings throughout and making renewal easier. The chief feature of the lay-out is that all the movable points are on the inside. Throughout the points and crossings are formed in one casting. A feature of the main track is that there are no intermediate pieces of rail, the points and crossings being continuous. The total weight of the lay-out is about 85 tons, and the weight of the points and crossings 30 tons.

ACCORDING to a circular recently issued by the firm, the business of Howell & Company, Limited, Sheffield Tube Works and Brook Steel Works, Sheffield, has been established over half a century. The founder, the late Mr. J. B. Howell, was the first to make crucible steel with under 0.20 per cent. of carbon, before the days of Bessemer and Siemens-Martin steels. Up to that time steel was looked upon only as a hard metal totally unsuited for constructive purposes, and is referred to as such in Percy's Metallurgy. Only a provisional specification for a patent was taken out because of the difficulty of completing it without informing the world of what was at that time a secret. The plates of the first ship made from steel were supplied and made by this firm; they made the first steel fire-box plates for locomotive boilers, and the founder of the company took out the first patents for steel tubes. The original business of the company was the manufacture of crucible cast steel and files, to which that of iron and steel tubes and fittings was subsequently added. An important sub-branch of the department of boiler-making is that of the manufacture of boiler tubes, which has been carried out at the works of Howell & Company, Limited, for the past 30 years.

THERE have been published recently reports on the results of some experiments in Germany on the addition of titanium in the manufacture of steel, which proved beyond doubt that the use of a certain percentage of such alloy led to the production of a steel which, in many respects, was far superior to that of ordinary manufacture. It has since been pointed out to us that one of the chief advantages of its use is that it acts as an excellent scavenger, and, of course, removes nitrogen from molten steel and iron. As an example, Bessemer rail steel containing 0.013 per cent. to 0.015 per cent. of nitrogen, when treated by the addition of ½ per cent. of ferro-titanium and 10 to 15 per cent. of titanium, showed a reduction of the nitrogen to 0.004 per cent. Titanium has a great affinity for oxygen, and is, therefore, an excellent deoxidiser. It also increases the fluidity of the bath. By the removal of nitrogen from steel, the physical qualities and density are improved. Steel in which titanium is used has increased in strength, hardness, and resistance to wear, as well as resistance to shocks and torsional strains. In the past experiments have been made in the use of titanium by an alloy containing in most cases too high a percentage of titanium, and a high percentage of carbon. Such alloys having a very high melting point were difficult, if not impossible, to use with any success. It is claimed, therefore, that the best results are obtained by using a prepared alloy, which should contain about 12 to 15 per cent. of titanium, and should be commercially free from carbon. The "Lion" brand, as produced by Geo. G. Blackwell, Sons & Company, Limited, at their Garston Works, Liverpool, contains this percentage of titanium, and is commercially free from carbon. It is a crystalline alloy, which dissolves readily in molten steel and iron. The consumption of ferro-titanium has increased very rapidly, and excellent results have been obtained, particularly in the United States, in the manufacture of titanium rail steel, as these rails, particularly on difficult curves, have shown the properties of resistance to wear to a remarkable degree.

Personal.

THE value of the personal estate of the late Mr. R. Groves Holland, of Sheffield, has been sworn at £75,859.

MR. H. HARMSWORTH and Mr. H. Cecil Walker have joined the board of R. Waygood & Company, Limited.

THE late Mr. Thomas Greenwood, engineer, of 688, Wh.tworth Road, Healey, Rochdale, left estate valued at £3,842 gross.

MR. H. L. SULMAN has been elected as successor to Mr. Edgar Taylor, as President of the Institute of Mining and Metallurgy.

MR. R. K. MORCOM, assistant managing director of Bellis & Morcom, Limited, has been elected a director of Lloyd's Bank, Limited.

THE late Mr. F. H. Harrison, chairman of Harrison & Company (Lincoln), Limited, malleable iron and steel founders, Lincoln, left real and personal estate of the net value of £63,503.

THE late Mr. G. Carmichael of James Carmichael & Company, Limited, Ward Foundry and Dundee Steam Forge, Dundee, left, in addition to real estate, personal estate valued at £84,503.

IT is officially announced that Lord Furness has accepted the chairmanship of Palmers' Shipbuilding and Iron Company, Limited, in succession to Sir Charles McLaren, M.P., resigned.

MR. H. BALLARD, of the Tees-side Bridge and Engineering Works, Limited, has been elected a director of the Cargo Fleet Iron Company, Limited, in place of the late Sir Walter Scott, Bart.

MR. F. W. BRIDGES, organiser of the Engineering and Machinery Exhibition at Olympia, London, has had the distinction of "Officier d'Academie" conferred upon him by the French Government.

MR. E. J. FOX, who has been connected for a number of years with Willans & Robinson, Limited, of Rugby, has resigned in order to take up an important appointment in London, with Stewarts & Lloyds, Limited.

MR. ALEXANDER TURNBULL, the founder of the firm of Alex. Turnbull & Company, Limited, of the St. Mungo Works, Bishop Briggs, near Glasgow, has retired from the managing directorship, but has agreed to retain the chairmanship of the company and to act as technical adviser to the Board. Mr. J. H. Johnson has been appointed general manager.

New Companies.

METAL FINISHERS (1910), LIMITED.—Capital £140 in 1s. shares.

SUCCESSORS TO SMITH'S FORGINGS COMPANY, LIMITED.—Capital £1,000 in £1 shares.

"REX" MACHINES SYNDICATE, LIMITED.—Capital £2,000 in £1 and 1s. shares, to carry on the business of engineers, etc.

CANADIAN-BRITISH ENGINEERING COMPANY, LIMITED.—Capital £100 in £1 shares, to carry on the business of ironfounders, etc.

THOMAS PEDLEY & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of ironfounders, pattern-makers, etc.

STUART LOCK-JOINT TUBE COMPANY, LIMITED.—Capital £6,000 in £1 shares. Registered office: 103, Bute Street, Cardiff.

TWISTED STEEL BAR COMPANY, LIMITED.—Capital £5,000 in £1 shares. Registered office: Billson Street Works, Isle of Dogs, E.

CHURNET VALLEY ENGINEERING COMPANY, LIMITED.—Capital £3,000 in £1 shares (400 deferred). Registered office: Churnet Foundry, Leek.

NEALE & FREUND, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 31, Budge Row, E.C.

O. G. SYNDICATE, LIMITED.—Capital £1,000 in 2s. shares, to carry on the business of ironfounders. Registered office: 51, Holborn Viaduct, E.C.

PIKE, BERWICK & KING, LIMITED.—Capital £12,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 18, Berkeley Street, W.

TYNESIDE ENGINE WORKS (1910), LIMITED.—Capital £20,000 in £5 shares, to take over the business of the Tyneside Engine Works (Cardiff), Limited.

NATIONAL REFRACTORY MINERALS PROCESS (MARTIN'S PATENT), LIMITED.—Capital £25,000 in £1 shares. Registered office: Salisbury House, Finsbury Circus, E.C.

FORD & PHILLIPS, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Regent Terrace, Glossop Road, Sheffield.

LAGERMAN PRESS, LIMITED.—Capital £10,000 in £1 shares, to carry on the business of ironfounders, mechanical engineers, etc. Registered office: 181, Queen Victoria Street, E.C.

J. B. SAUNDERS & COMPANY, LIMITED.—Capital £20,000 in £1 shares (6,000 "A." and 14,000 "B."), to carry on the business of engineers, etc. Registered office: 91, York Street, Westminster, S.W.

INVENTIONS AND GENERAL SYNDICATE, LIMITED.—Capital £5,250 in 5,000 "A" shares of £1 each and 5,000 "B" shares of 1s. each, to carry on the business of founders, etc. Registered office: 14, St. Mary Axe, E.C.

GEORGE WALKER & SONS (BIRMINGHAM), LIMITED.—Capital £10,000 in £1 shares (4,000 preference), to carry on the business of tile and tool manufacturers, founders, engineers, etc., and to adjust an agreement with G. Walker.

TARDY & THURDIN, LIMITED.—Capital £1,000 in £1 shares, to take over the business of general engineers, etc., carried on by H. Tardy and C. V. Thurdin at 84, New North Road, London, as the Small Tool Manufacturing Company.

TENTER FOUNDRY COMPANY, LIMITED.—Capital £1,500 in £1 shares, to take over the business of ironfounders, manufacturers of and dealers in malleable iron castings, carried on at Rotherham by F. C. Morwood and J. A. Potter as the Tenter Foundry Company.

QUALTER, HALL & COMPANY, LIMITED.—Capital £15,000 in £10 shares, to acquire the business of engineers and founders, as formerly carried on by Messrs. T. B. Hall, G. H. Hall, and W. E. Hall, at the Railway Foundry, Barnsley, as Qualter, Hall & Company.

DAIMLER COMPANY, LIMITED.—Capital £250,000 in £1 shares, to carry on the business of manufacturers of and dealers in motors, cycles, motor boats, etc., and to adopt an agreement with the Daimler Motor Company (1904), Limited, E. Manville, and the Birmingham Small Arms Company, Limited.

JAMES HORTON, LIMITED.—Capital £7,000 in £1 shares, to take over the business of a malleable and general ironfounder carried on by C. Constable, Mrs. E. Constable, G. Foster, and Mrs. E. Foster, at Walsall Street and Dale Foundries, Willenhall, as James Horton. Registered office: 110, New Road, Willenhall.

POULSON'S FOUNDRY SPECIALITIES, LIMITED.—Capital £5,000 in £1 shares, to acquire from A. Poulson, inventions and discoveries relating to improvements in the manufacture of refractory silica and refractory bricks and the like, and in the treatment of moulders' sand. Registered office: 7, East Parade, Leeds.

HENRY MOORE, LIMITED.—Capital £10,000 in £1 shares, to take over the business of brass and ironfounders carried on at Star Works, Rupert Street, Birmingham, as Henry Moore, and to adopt an agreement with H. Moore, Albert Moore, and Arthur Moore. Registered office: Star Works, 37 and 38, Rupert Street, Birmingham.

SUPERHEATED STEAM ENGINE AND GENERATOR SYNDICATE, LIMITED.—Capital £20,000 in £1 shares, to acquire patent No. 5,001 of 1901 for compound, single-acting steam engine, granted to H. Bentley, and patents No. 2,282 and 2,283 of 1910 for steam generators and liquid fuel burners, granted to G. K. Field and J. Burns. Registered office: 15, Angel Court, E.C.

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COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

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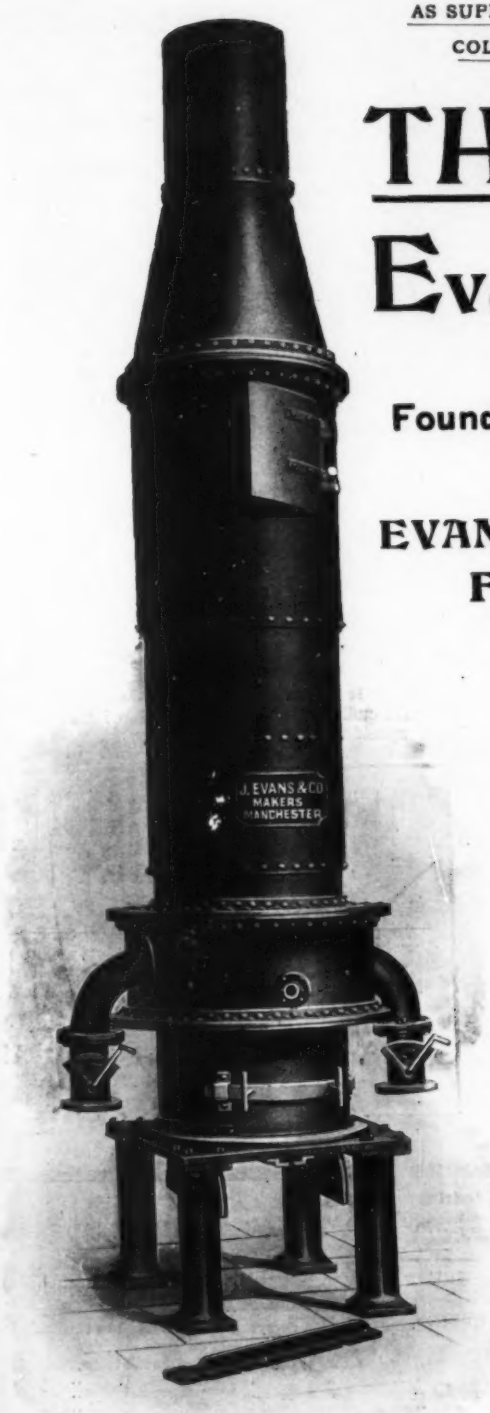
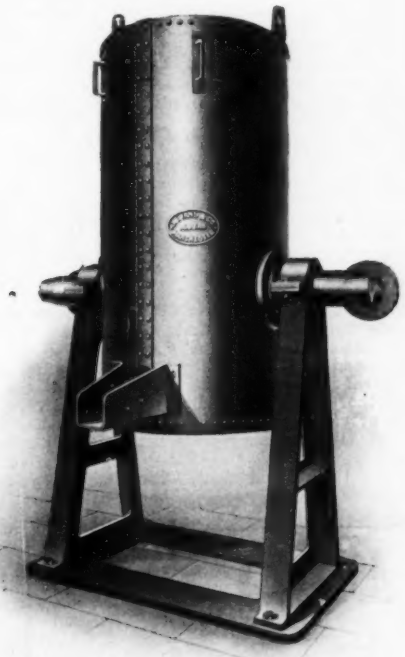
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Legal.

Friendly Society of Ironfounders v. Ingall.

Before Judge Benson, in the Sheffield County Court, recently, the adjourned action of the Friendly Society of Ironfounders *v.* Ingall was concluded. It will be remembered that the Society sought to recover £100 from H. Ingall, moulder, moneys paid to him in respect of an accident. There was an agreement that if Ingall should resume work in any department of an iron foundry he should forfeit the £100. Ingall unexpectedly recovered from the injuries he sustained in the accident and renewed work early this year.

Counsel for the Society said that a special defence had been put in under Section 4 of the Trade Union Act, 1871, which stated that no Court should be able to entertain proceedings with the object of directly enforcing or recovering damages for breach of agreement for the application of funds of a Trade Union or the payment of benefits to members, but this was not an agreement for the application of Trade Union funds. The funds had been already applied; the money was paid before the agreement was signed. The agreement only dealt with the repayment by the member of the benefit already received. Supposing the defence succeeded in establishing that the agreement came within Section 4 of the Act the action was still maintainable if the Society would not have been unlawful before the Act of 1871.

Counsel for the defence pointed out that the agreement referred to the renewing of work as an ironfounder, but there was a stipulation enlarging the definition of ironfounder. This the Society could not legally do, as defendant received no consideration. He contended the Society was illegal before the passing of the Trade Union Act because it had rules which fettered a man in his employment, and through those rules sought to deprive him of benefits received in connection with the Friendly Society part of their work.

Judgment was reserved.

Robinson & Company v. Taylor.

At Falkirk, Sheriff Principal Lees has decided an appeal in an action by C. W. Robinson & Company, Forth Bridge Steel Works, Polmont Station, against John Taylor, dresser, Polmont Station. The plaintiffs sued for payment of £85 0s. 4d. alleged to be due to them in respect that they had in error overpaid defendant on 64 tons, 3 cwts., 1 qr. of castings, the same not having been dressed by him under his contract. Defendant denied overpayment, and pleaded that the action was irrelevant, and that in any case, he having been prejudiced by plaintiffs' negligence and having suffered loss and damage, thereby the action should be dismissed. Sheriff Substitute Lockhart decided the action in favour of the defendant, holding that the plaintiffs had failed to prove any overpayment, and that in law, even assuming they had, they were not entitled to repayment of any monies paid to defendant. Sheriff Lees has adhered to that judgment, with further expenses.

Queries.

Plaster of Paris.

Will any of your readers be kind enough to tell me how to mix plaster of Paris, and how to treat same when cast? Anything about plaster blocks will be much esteemed. "READER."

Phosphor Bronze Difficulties.

We are making castings for worm gearing, and in some of this gearing a phosphor-bronze worm wheel works with a case-hardened steel worm. Some of the wheels come out satisfactorily, while others are very soft, with the result that after they have been in operation with the worm some time, the teeth, as a result of the phosphor-bronze being soft, entirely wear away. The mixture is as follows:—87.5 per cent. copper, 6.0 per cent. phosphor tin, 5.0 per cent. block tin, 1.5 per cent. lead. Perhaps the variation may be due to some discrepancy in the melting of the metal. Any information on the matter from your readers will oblige. "W.A."

Reply.

Facing Sands.

As this query in the last issue is not quite explicit, may I presume it is for green-sand mouldings? "Novice" requires facing-sand, and he says his work is from 1 cwt. to 10 cwts., but to a practical man this is very indefinite. If he had added to this thickness of metal, and also if his castings were machined or otherwise, a mixture might have been given right away. In "General Foundry Practice," by Roxburgh, will be found much information on sands, but if this is not sufficient the requirements of "Novice" should be specified more particularly. "SUBSCRIBER."

GEORGE GOULD,
OLD CANAL WHARF,
STOURBRIDGE.
FOUNDRY SAND
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PIG-IRON	Determination of 1 Constituent	..	£0 6 6
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STRONG, CLOSE-GRAINED

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"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, mor free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End Oct., 1910.	End Nov., 1909.
Iron—Scotch pig warrants ton	*55/4½	*56/10½
—Middlesbro' warrants ... ton	49/7	51 0
—W.C. Mixed Bessemer ... ton	66 6	61/6
—Stock, Scotch ... ...tons	1,660	1,000
Copper—Chili bars, GMB ton	£57 11 3	£59 11/3
—Stock, Europe and afloat tons	†86,609	†102,952
Tin—English ingots ... ton	£170 5/0	£138 0 0
—Straits ... ... ton	£170 0 0	£142 5/0
—Stock, London, Holland, U.S.A., and afloat ...tons	‡18,387	‡19,680
Lead—English pig ... ton	£13 11 3	£13 8/9
Spelter—Ord. Silesian ... ton	£24	£23 5 0
Quicksilver (75lb)... bottle	£8	£9 17 6
Antimony—Regulus ... ton	£28 0/0-£29 0/0	£29 10/0

* Settlement price. † November 15. ‡ October 31.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1¼ to 2¼ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 7s. 6d.; all per ton f.o.b., London. Copper (clean), £54 10s. 0d.; brass (clean), £39 10s. 0d.; lead (usual draft), £12 5s. 0d.; tea lead, — ; zinc, £19 10s. 0d.; all per ton delivered merchant's yard

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In their monthly mineral report, Messrs. S. W. Royse & Company, of Manchester, remark that prices of iron ore are steady, but only a very moderate business is being done. Imports showed some little decline in September and again in October, but during January 1—October 31, this year, as compared with the corresponding period of last, there is still an increase of 742,805 tons valued at £1,014,158. Manganese and chrome ores are unchanged as to values, and have latterly somewhat more enquiry. In pyrites also there has been more business doing, some mines in Norway having been in difficulties about delivery.

Deaths.

Mr. G. Nancarrow, general manager of the Morfa Copper Works, Swansea, died recently at his residence, Llwyn Helig, Swansea, at the age of 52.

The death is announced of Mr. A. Dishington, J.P., a director of Taylor, Lang & Company, Limited, Castle Iron Works, Stalybridge, aged 75 years.

Mr. L. H. Larmuth, of Thos. Larmuth & Company, Limited, of the Todleben Iron Works, Cross Lane, Manchester, died recently, aged 67 years.

Mr. R. Hill, chairman of Richard Hill & Company, Middlesbrough, died recently, at his residence, Holly Mount, High Hurstwood, at the age of 83 years.

Mr. W. Abell, head of the engineering and iron-founding firm of William Abell, Limited, Derby, died on October 22, at his residence, Stockbrook Villa, Uttoxeter New Road. He was in his 67th year.

The death occurred on Tuesday, October 25, at his residence, Brookdale, Northwich, of Mr. Ralph White, sole partner of Messrs. R. White & Company, of the Novelty Iron Works, Northwich, Cheshire. The deceased gentleman, who was but 57 years of age, was well known in Cheshire engineering circles.

The death is reported of Mr. Harry Christopher Furness, nephew of Lord Furness. It appears that Mr. Furness met with a serious accident at the residence of his father, in Wiltshire, and he succumbed to his injuries shortly afterwards.

The death occurred at Shffield, last month, of Mr. Frank William Wells, who for 15 years was chief Admiralty overseer at Sheffield. Latterly, Mr. Wells had been associated with the armament department of Vickers, Sons & Maxim, Limited. He was 70 years of age.

The death was announced, on November 4, at the age of 74, of Mr. J. Norris, of Foundry House, Welshpool, and Borth, Cardiganshire. Mr. Norris, who had been ailing for some time, past, was senior member of the firm of J. & M. Norris, ironfounders and agricultural implement makers, Welshpool.

Mr. P. Baird, a retired foundry manager, Falkirk, died recently in his seventy-first year. A moulder by trade, the deceased started the Forth and Clyde Iron Works, under the style of Baird, Cowie & Hasting, the business being afterward disposed of to Messrs. Brown, Dickson & Company. Mr. Baird subsequently held a number of foundry appointments.

Mr. J. E. Wilson, of West Bromwich, died on November 8. Mr. Wilson was a native of the town, and early entered the service of his uncle, Mr. Thomas Davis, Junr., at the Golds Hill Iron Works. On his uncle's retirement, he, in company with Mr. T. J. James, acquired the business, and carried it on for some years. He was also largely interested in other concerns in the district, being a director of F. W. Cotterill, Limited, John Bagnall & Sons, Limited, and John Brotherton, Limited.

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FOUNDRY EQUIPMENTS,

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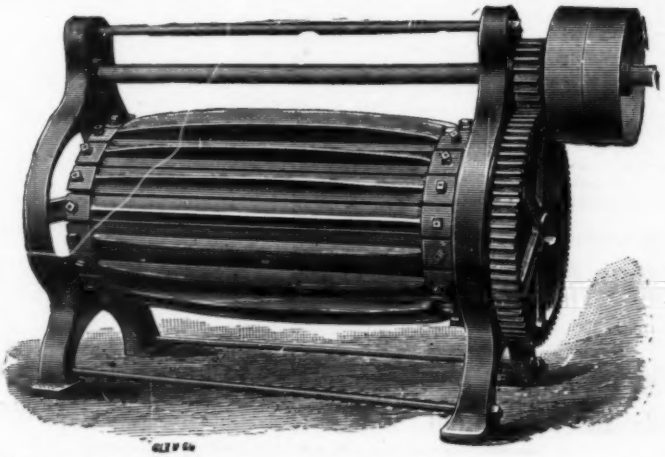

These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

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We have heard this expression many times when showing Foundrymen this photo of one of the up-to-date foundries equipped by us. The sand is carried to the Moulding Machines by an overhead conveyor and is delivered into the moulding boxes by trays ; the operator shovels in the facing sand, that's all. The metal is brought to the men by the overhead runway shown, and the boxes are shaken out over the grating in the middle, under which is a conveyor which carries the sand back to the Sand Preparing Machines.

Result—Costs reduced to half and first-class Castings.

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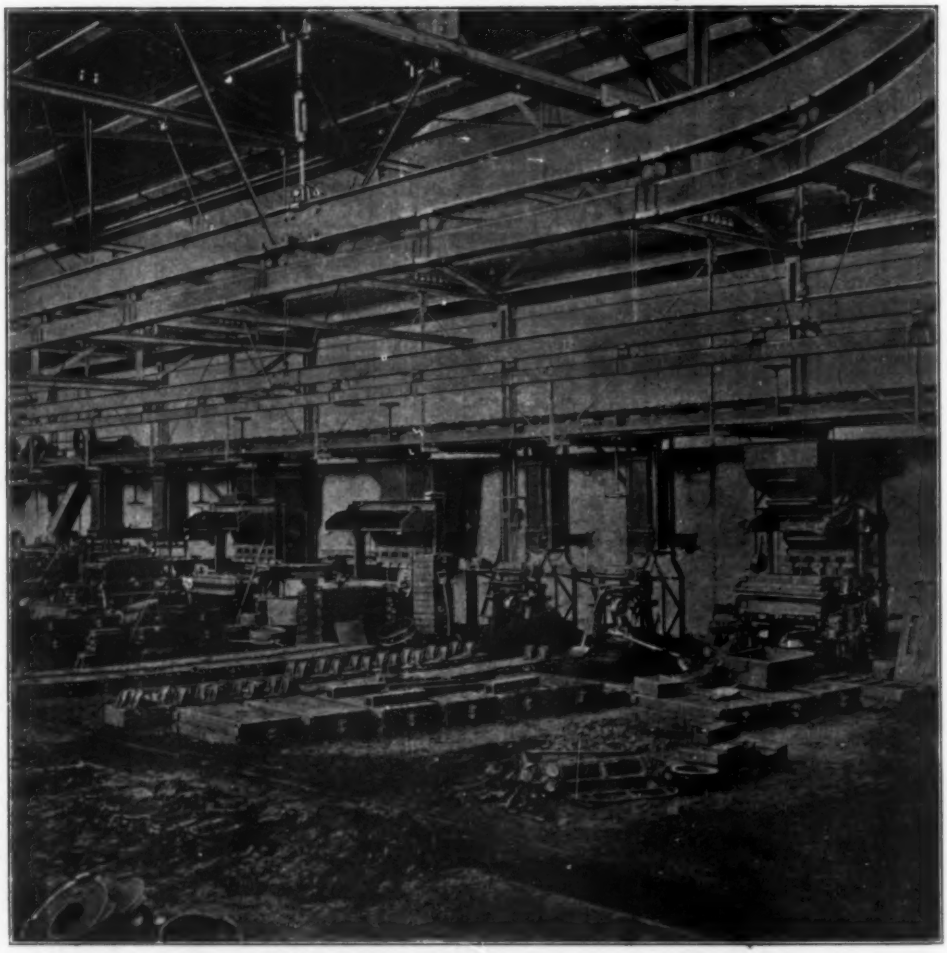

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Charcoal.
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Firminger, J. & Co., Ltd.
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Jackman, J. W., & Co., Ltd.
Sykes, James.
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Coal Dust.
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Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
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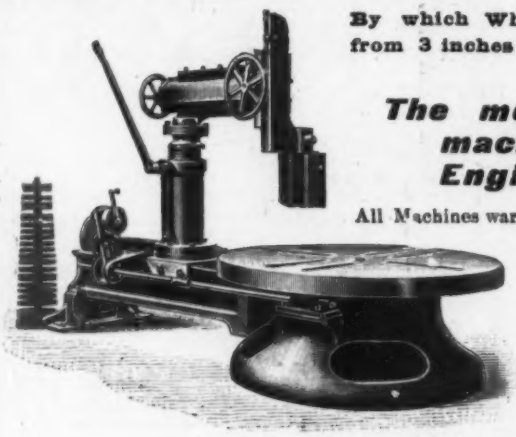

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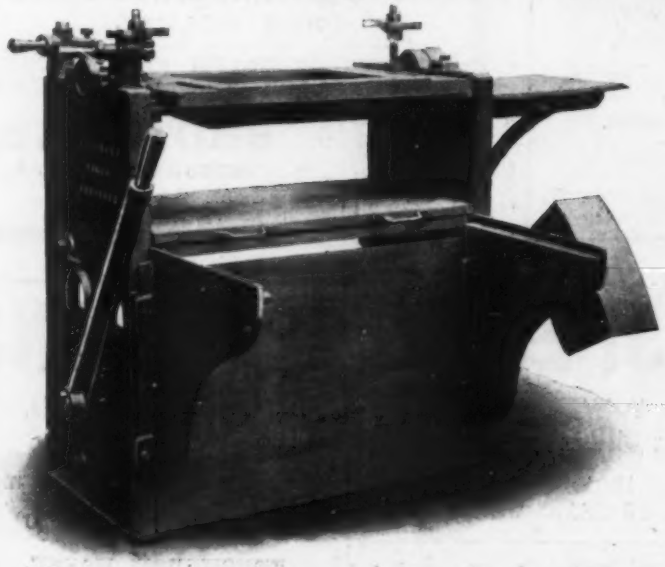

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